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Record of Decision:

BRODERICK WOOD PRODUCTS
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EPA Superfund Record of Decision:

Broderick Wood Products, CO

DECLARATION STATEMENT
for
RECORD OF DECISION
BRODERICK WOOD PRODUCTS
ADAMS COUNTY, COLORADO
OPERABLE UNIT 2 - FINAL SITE REMEDY
MARCH 1992

SITE NAME AND LOCATION

Broderick Wood Products
Adams County (unincorporated), Colorado

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for Operable Unit 2 (OU 2) at the Broderick Wood Products (BWP) Superfund site which is located at 5800 Galapago Street in unincorporated Adams County, Colorado. The selected remedial action is treatment of the soils, sediments, and surficial ground water, and demolition and recycling/landfilling of buildings, and recycling of building contents at BWP. The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision document explains the basis for selecting the remedy for the soils, sediments, ground water, and buildings and building contents at this site. The information that forms the basis for this remedial action decision is contained in the Administrative Record for this site and is summarized in the attached Decision Summary.

The State of Colorado concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from thissite, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The BWP site has been divided into two operable units: interim actions/source control (OU 1) and final remedy (OU 2). In June 1988, EPA issued a ROD to address source control and the direct contact exposure pathway. The major components of the June 1988 ROD were restriction of site access, excavation and on-site incineration of sludge, stockpiling or on-site incineration of visibly contaminated soils beneath the impoundments, and treatment of water in the impoundments and buildings. Based on new technical data and cost information obtained subsequent to the June 1988 ROD, EPA revised its decision to employ on-site incineration as a source control measure for OU 1. New data evaluated by EPA included technical data on the interaction of contaminants and ground water received from continuing

RI/FS activities for OU 2 and cost information for on-site incineration received during remedial design for OU 1. A ROD Amendment for OU 1, issued on September 24, 1991, describes the revised interim action, which involves off-site recycling of the impoundment sludges.

The selected remedy presented in this ROD addresses the principal threats posed by the site. They are the soils, sediments, ground water, buildings and building contents that contribute to contamination at the BWP site and from OU2. These medial contain elevated concentrations of pentachlorophenol, polynuclear aromatic hydrocarbons, volatile organic compounds, and chlorinated dioxins and furans. A portion of the site soils also contain elevated concentrations of metals left from pre-BWP operations at the site. Inhalation and ingestion of, and direct contact with these contaminants have been determined to pose a threat to human health from the soils, sediments, ground water, buildings and buildings contents. The final site remedy is intended to mitigate these exposure pathways and includes the following components:

Soils/Sediments. The selected remedy will use the following technologies and controls to address contamination in soils and sediments:

- Approximately 59,000 cubic yards of soils most highly contaminated with organics will be excavated and bioremediated in a land treatment unit (LTU). The length of the total treatment process is estimated at seven years. Since the Land Disposal Restrictions (LDRs) will not be met at the time of placement in the LTU, these LDRs are waived under an interim measures waiver. The LDR treatment standards will be met at the end of the remedial action by a soil and debris treatability variance.

- Approximately 120 cubic yards of organics-contaminated sediments in Fisher Ditch will be excavated and treated to remove water, as necessary, in preparation for subsequent treatment with the organics-contaminated soils.

- Approximately 800 cubic yards of soils contaminated with heavy metals will be treated through chemical fixation to form a chemically and mechanically stable material. This material will then be disposed at an off-site, RCRA-permitted, solid-waste landfill.

- The existing surface impoundments will be closed in accordance with RCRA requirements.

- Exposure to organics-contaminated soils at lower levels remaining after excavation treatment will be controlled by the use of institutional controls, such as deed restrictions, to prohibit future residential and agricultural use of the site.

Ground Water. The selected remedy will use the following technologies and controls to address ground water contamination in the three aquifers under the site:

- Approximately 526 million gallons of ground water and light (floating) non-aqueous phase liquids (LNAPL) from the surficial aquifer will be recovered in a recovery system, such as subsurface drain trenches and recovery wells. A two-phase (ex-situ and in-situ) biological water treatment process will then remove LNAPL in an oil/water separator. The LNAPL will be reclaimed by shipping it to an off-site recycling facility. The remaining water will be treated in a twostage, fixed-film bioreactor, mixed with nutrients and an oxygenating chemical, then reinjected into the aquifer to stimulate bacterial growth to promote further breakdown of contamination within the shallow aquifer.

- Small amounts of dense non-aqueous phase liquids (DNAPL) and ground water will also be collected from existing monitoring wells in the Denver aquifer, treated in the oil/water separator, and sent to an off-site recycling facility.

- Ground water in all three aquifers under the site will be periodically monitored for thirty years using approximately 10 to 15 wells to assess ground water quality and migration of contaminants.

- Additional monitoring wells will be drilled in the Arapahoe aquifer to further test the aquifer and to collect and analyze additional ground water samples to provide additional information about ground water contamination in this aquifer, if any.

- Institutional controls, such as deed restrictions, will be placed on the property to control access to water in the surficialand Denver aquifers. Federal and State ground water standards identified as applicable or relevant and appropriate requirements (ARARs) are not expected to be met in the Denver aquifer. These ARARs are waived due to technical impracticability.

Buildings, Vessels, and Drums. The selected remedy will address contamination in buildings, vessels, and drums as follows:

- Buildings will be demolished and building debris will be decontaminated and temporarily stockpiled on-site.

- Approximately 225 tons of scrap metal will be decontaminated and transported to an off-site reclamation facility.

- Vessel and drum contents, including an estimated 42,000 gallons of organics and sludges, will be pumped or excavated, stored temporarily on-site, and then transported, in drums, to an off-site reclamation facility.

- Approximately 9,500 gallons of contaminated water in building sumps or basements will be pumped, stabilized, drummed and transported to an off-site, permitted hazardous waste landfill.

- An estimated 850 cubic yards of building debris and 205 cubic yards of asbestos-containing materials will be disposed in an offsite, permitted landfill.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action (or justifies a waiver of any Federal and state ARARs which will not be met) and is cost-effective. This remedy utilizes permanent solutions and alternative treatment or resource recovery technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review of this remedy will be conducted no less often than each five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

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for
RECORD OF DECISION
BRODERICK WOOD PRODUCTS
ADAMS COUNTY, COLORADO
OPERABLE UNIT 2 - FINAL SITE REMEDY
MARCH 1992

I. SITE NAME, LOCATION AND DESCRIPTION

The Broderick Wood Products (BWP or Broderick) Superfund site is located at 5800 Galapago Street in unincorporated Adams County near Denver, Colorado (Figure 1). The City and County of Denver corporate boundary is about 3,000 feet south of the site, and Interstate Highway 25 at 58th Avenue is about onehalf mile east of the site. The triangular-shaped BWP property encompasses approximately 64 acres and is situated in a primarily industrial area. It is bounded on the southwest by a right of way of the Colorado and Southern Railroad, on the southeast by a right of way of the Denver and Rio Grande Western Railroad, and on the north by Fisher Ditch. Also southeast of BWP is the Koppers Company, an active wood treating operation. The 1990 census for the three zip codes nearest the site (80211, 16, and 21, a radius of approximately three miles) indicated a population of 106,928 in the area surrounding the site.

The major site features (Figure 2) include two unlined surface impoundments (main and secondary) and a total of 23 structures. The structures include several storage buildings, the main office, a change room, a water pump house, two wood fabrication shelters, the treatment and boiler building, and a shop building. Underground structures at the site include the treatment building basement and two cylinder basements. In addition, there are 16 vessels including storage tanks, an air cylinder, and a pressure cylinder on the site. The capacities of these vessels range from 2,400 to 50,000 gallons. Approximately 70 drums of a variety of chemicals, oils, and asbestos continue to be stored in the process area and an additional 65 drums of oil from sludge are stored in the impoundment area of the site.

The BWP site is located on an elevated alluvial terrace about onehalf mile south of Clear Creek. The site is not within the Clear Creek 100year floodplain. The surface of the site is relatively flat but dipsgently to the northeast. Surface elevations range from 5,206 feet in the northeastern corner of the site to 5,227 feet in the southern corner (EPA 1988). There is little surface run-on, or run-off at the site because of existing topographic restraints and man-made barriers, such as ditches or railroad cuts or embankments along site boundaries.

Ground water is present in a series of three water-bearing geologic units beneath the site. Surficial eolian deposits, Slocum Alluvium and the weathered Denver Formation comprise the surficial aquifer. These surficial deposits range in thickness from 18 to 35 feet. The unweathered Denver Formation (Denver aquifer), composed of claystones with interbedded sandstone lenses, underlies the surficial aquifer, constitutes the bedrock at the site, and is approximately 150 feet thick. The upper Arapahoe Formation (Arapahoe aquifer), composed of interbedded sandstone, siltstone and clay shale, underlies the Denver aquifer, and occurs in thicknesses of 500 to 600 feet (see Figure 3). The upper two units are recharged by subsurface inflow and infiltration of surface water. The ground water flow in the surficial and Denver aquifers is generally towards the north-northeast. The ground water flow in the Arapahoe aquifer is generally more to the north and recharge is from outcrops approximately fifteen miles south and west of the site. Some residences north of the site use ground water wells for irrigation purposes. However, all of these residences are currently connected to a

municipal water supply system for household use.

Access to the site is presently restricted by a locked, six-foot chain-link security fence topped with barbed wire and posted with warningsigns. The main entrance gate is located at the southern tip of the site. The main and secondary impoundments are surrounded by a wooden-slat snow fence approximately three-feet high. The treatment plant building is also surrounded by a six-foot chain-link fence posted with warning signs.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Operations History

The BWP Company operated a wood treating facility at this location to treat power poles, fence posts, railroad ties, and other wood products from 1947 to 1981. Creosote was used as a wood treating chemical throughout the life of the facility and was mixed with a carrier oil (fuel oil) for application. Pentachlorophenol (PCP), which was dissolved in a carrier oil, was used on a limited basis prior to 1953 and regularly between 1953 and 1980.

During the operational life of the facility, process waste from the plant was disposed of on the site, with much of it going to the impoundments located in the northwest corner of the site. The waste was conveyed to the impoundments through a ten-inch diameter clay, bell- and spigot pipe. Release of contaminants from the impoundments has occurred from leaching through the underlying soils to ground water as well as volatilization and fugitive dust emissions from the impoundment surface.

The main impoundment is reported to have been constructed in 1946 by filling in the ends of a railroad cut. Historical aerial photographs indicate that the main impoundment extended much closer to the northern site boundary during the early years. In 1956, a secondary impoundment was constructed west of the main impoundment for additional evaporation capacity and as an overflow structure for the main impoundment. In 1962, the main and secondary impoundments caught fire and burned for several hours.

In November, 1981, BWP ceased operations as a wood treater, citingmarket conditions. Seven months later, in June 1982, BWP's assets were liquidated into a trust-operated partnership known as the Broderick Investment Company (BIC), a Colorado limited partnership. The trustees of the partnership were the First National Bank (now the First Interstate Bank of Denver) and the Colorado National Bank of Denver. Shortly thereafter, the BWP Company was officially dissolved, making BIC the successor to BWP Company's business interest.

CERCLA Enforcement History

The recent history of the site has included numerous activities and investigations of contamination on and off the site. Most of these activities have been in response to or in coordination with regulatory and legal actions by the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH). A detailed history of enforcement activities was provided in the Summary Document (January 1991) prepared for EPA and placed in the Administrative Record. Major enforcement activities prior to June 1988 included EPA investigations under both the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), which lead to placement of the BWP site on the National Priorities List (NPL) in September 1984. Remedial Investigation/Feasibility Study (RI/FS) activities began in 1985 and have been conducted in three phases. In late 1985, EPA and BIC reached agreement on the terms of a Partial Consent Decree (PCD) under which the defendants agreed to pay $100,000 for the alleged violations of RCRA interim status regulations. The PCD also established a framework for the defendants to conduct a CERCLA-type RI/FS, with a corresponding stay of discovery and litigation pending completion of the RI/FS and selection of remedy. The decree covers conduct of the Phase III RI/FS as well as the Phase II RI/FS studies. Phases I and II were sufficient to allow selection of interim actions to remediate the site.

Interim Remedial Actions

In June 1988, EPA issued a Record of Decision (ROD) for the BWP site based on the Phase I and II RI/FS efforts. This ROD identified interim actions to control the major source of contamination at the site and to address risks from direct contact exposure to site contaminants. The major components of the June 1988 ROD were restriction of site access, treatment of water in the impoundments and buildings, excavation and incineration of sludges, and stockpiling or on-site incineration of visibly contaminated soils in the impoundments (referred to as Operable Unit 1 or OU 1). The ROD also specified that cleanup actions for buildings, vessels and surface soils, and monitoring of the effectiveness of the remedies, would be determined as a part of Phase III studies for Operable Unit 2 (or OU 2) at the site.

In May 1990, BIC filed a petition for reconsideration of the June 1988 ROD with the Regional Administrator of Region VIII. EPA decided to reconsider the June 1988 ROD due to the cost information acquired during design of the remedy and new technical data on the interaction of contaminants and ground water from the Phase III RI/FS activities. EPA had determined that removal and storage of the sludges would be necessary under any alternative selected. As a result, EPA requested and BIC agreed in October 1990 to proceed with removal of the sludges from the two impoundments.

Two temporary lined cells were constructed on the Broderick property in the area of the secondary impoundment. Sludges from the secondary impoundment were stockpiled temporarily until the solid sludge storage cell was completed. Approximately 950 cubic yards of solid sludges have been stored in a single-lined cell with leachate collection in accordance with 40 CFR, Subpart L - Waste Piles. Approximately 1,220 cubic yards of liquid sludges have been stored in a double-lined cell with leak detection in accordance with 40 CFR, Subpart K - Surface Impoundments. In addition, a quantity of oil has been collected from the sump of the solid storage cell and stored in 55gallon drums. Storage of the sludges is temporary until implementation of the remedy selected in the OU 1 ROD Amendment. Removal of the sludges to an off-site recycling facility is the Interim Remedial Action selected in the OU 1 and ROD Amendment. All components of the June 1988 ROD that were not addressed by the ROD Amendment are being addressed by this ROD.

Remedial Investigation/Feasibility Study

The Phase III RI was finalized in December 1990. The Phase III RI identified contaminated ground water, contamination in surface soils, and "hot spots" of contamination at the site including buildings and vessels. An Endangerment Assessment was issued in May 1991 and identified the major pathways for exposure to contamination as ingestion, inhalation, and dermal contact. Depending on future site use, the populations with the highest potential risk from exposure to contamination were on-site resident young children, on-site construction workers, and on-site industrial workers. The Final Feasibility Study, dated June 28, 1991, identified ten detailed alternatives for cleanup of contaminated soils and sediments, shallow ground water, and buildings and buildings contents.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Community interest at the Broderick Wood Products site generally has been low to date, with involvement primarily from residents and businesses located in the vicinity of the site as well as from state and local officials. Community interest and concern increased somewhat in 1989 after selection of on-site incineration as the remedial technology to treat contaminated sludges at the site. Concerns about the RD/RA process again decreased with announcement of the revised plan to treat sludges via reclamation and off-siteincineration. There has been some media coverage of the site, primarily corresponding to key points in the Superfund process or following meetings with the public or with local officials. Further detail of community involvement at the BWP site is presented in the Responsiveness Summary of this ROD. The public participation requirements as specified in CERCLA Section 113 (k)(2)(B)(i-v) and Section 117 have been met as described below.

In June 1988, EPA issued the Record of Decision for OU 1. A second volume of the ROD, the community involvement and responsiveness summary, summarized community involvement activities conducted for the site and provided responses to official public comments on the Proposed Plan for OU 1. Responses addressed both the 41 oral and written comments, as well as BIC's comments submitted during and after the public comment period.

Between June 27, 1989 and June 28, 1989, EPA met with six representatives of the community to identify any new concerns they might have about the RD/RA process. Additionally, on July 11, 1989, EPA held two separate briefings for state and local officials, businessmen, residents, and concerned community groups to describe the RD/RA process and identify and address any community concerns.

Major concerns regarding the remedial action expressed at these meetings included concern about the safety and efficiency of on-site incineration, concern about possible community opposition to on-site incineration, and concern about potential traffic and road impacts from the remediation. Other concerns expressed included concerns about potential surface and ground water contamination off the Broderick property from the site (including the potential for contamination to migrate into private wells), and continuing site access issues. These meetings produced requests for more detailed information about the specific incineration process to be employed at the site, about ongoing RI/FS work to characterize and remediate the entire site, and about other Superfund sites near Broderick.

On May 24, 1990, BIC submitted a petition to the U.S. EPA Regional Administrator for Region VIII that provided additional information about the site and requested a change in the remedy from the June 1988 ROD. From May 1990 through December 1990, EPA reviewed this information and additional information gained in ongoing site investigations, in order to evaluate whether the decision to employ on-site incineration continued to be the most appropriate remedial alternative to treat sludges in the surface impoundments. In late 1990, following a review of all applicable information, EPA reached a decision to prepare a new Proposed Plan for the treatment of impoundment sludges.

In mid-January 1991, EPA prepared a "Summary Document - Post-ROD Activities" (EPA, 1991) which summarized and described the data and findings of cleanup investigations that led to a reevaluation of the sludge treatment remedy selected in the June 1988 ROD. This document was placed in the Administrative Record files at the information repositories.

The final Phase III FS Report was completed on June 28, 1991 and an Addendum to the FS was completed on July 11, 1991. Based on these documents, EPA identified its Proposed Plan for OU 2 and described it in a fact sheet mailed to the public on September 19, 1991. This fact sheet was sent to 232 persons on the mailing list. This fact sheet described the Proposed Plan for treatment of soils, sediments, ground water, buildings, and building contents. The fact sheet also described opportunities for public involvement including the public meeting and the public comment period for the OU 2 Proposed Plan.

On September 17, 1991 and September 18, 1991 respectively, public notices were placed in two Commerce City weeklies, the Beacon and the Express, announcing a public comment period from September 23, 1991 to October 23, 1991for comments on the Proposed Plan for OU 2. Also, on September 22, 1991, EPA placed a quarter-page public notice in the Rocky Mountain News with the same announcement. The notices also announced the October 9, 1991 public meeting, and informed the public of the availability of all pertinent information at the two information repositories:

EPA Superfund Record Center
999 18th Street
Denver, CO 80202
(303)293-1807

Adams County Public Library
Commerce City Branch
7185 Monaco Street
Commerce City, CO 80022

(303)287-0063
Hours: Mon - Fri: 8:30 am to 4:30 pm   Mon, Th: 1:00 pm to 8:00 pm
Tu, W, F, Sat: 10:00 am to 5:00 pm

The public meeting to discuss the OU 2 Proposed Plan was held on October 9, 1991 at the Inn at the Mart located near the site. A transcript of the meeting was prepared for placement in the Administrative Record files at the information repositories. At the meeting, which was attended by 25 community members, only two oral comments were received.

Between September 23, 1991 and November 22, 1991, EPA met with concerned citizens, representatives of several community groups, and local officials to identify any questions they might have about the OU 2 Proposed Plan. Additionally, on November 12, 1991, EPA held a briefing for state and local officials and Congressional staff members to describe the Proposed Plans for the Broderick Superfund site, together with those for three other Superfund Sites in northern Denver and southern Adams County.

During the public comment period for the OU 2 Proposed Plan (which was extended to November 22, 1991), EPA received written comments from attorneys for BIC, attorneys for Brannan Sand and Gravel Co., the Fisher Ditch/United Water Co., and the U.S. Fish and Wildlife Service. Responses to official public comments, both verbal and written, are presented in the Responsiveness Summary attached to this ROD. IV. SCOPE AND ROLE OF OPERABLE UNIT

The problems at the Broderick site are complex. As a result, EPA has organized the work into the following two operable units (OUs):

- OU 1: interim actions, and

- OU 2: final remedy.

The June 1988 ROD for Operable Unit 1 (OU 1) and its subsequent Amendment issued on September 24, 1991, selected specific interim actions to be taken as part of the initial cleanup. The interim actions were selected to meet the objectives of addressing the principal threats to human health and the environment. These threats were associated with the ease of site access and the potential for direct contact with the impoundment wastes. These wastes, consisting of sludges remaining from disposal of wood-treating chemicals into the impoundments, were the major source of contamination at the site. These sludges therefore posed the principal threat due to the potential for inhalation and dermal contact with chemical wastes from the creosote and pentachlorophenol wood treating processes. By placing these sludges in lined and covered storage cells, this threat has been temporarily isolated from the soils and ground water. Removing and treating the sludge will eliminate this primary source. Remedial design for the removal and transport of the sludge is proceeding.

Site access has been restricted through construction of a fence around the entire BWP site. The June 1988 ROD deferred decision on a remedy for the buildings and vessels, and surface soils to this final action.

OU 2, authorized by this ROD, addresses the remaining areas of the site. The Phase III RI/FS was initiated to fill data gaps from previous site investigations that prevented selection of a final site remedy. Specifically, EPA identified additional work that was necessary to remediate the site, particularly with regard to ground water and the principal threats of soils/sediments, NAPLs and the structures and their contents. Sitehazards addressed as part of OU 2 include:

- Contaminated soils
  - organics-contaminated soils
  - metals-contaminated soils

- Organics-contaminated Fisher Ditch sediments

- Contaminated ground water
  - surficial/weathered Denver aquifer
  - Denver aquifer
  - Arapahoe aquifer

- Buildings, vessels, and drums.

The Phase III RI/FS effort included sampling of existing ground water wells on the site and on the property north of the site, as well as soil sampling and bench scale bioremediation studies of the soils. The Phase III RI report was completed on December 20, 1990 and the FS report was completed on June 28, 1991 and subsequently revised.

V. SITE CHARACTERISTICS

Site Geology and Hydrology

The BWP site is situated on an elevated Quaternary alluvial terrace about one-half mile south of Clear Creek. The site is located above the Clear Creek 100-year floodplain. The surface of the site is relatively flat but dips gently to the northeast. Surface elevations range from 5,206 feet in the northeastern corner of the site to 5,227 feet in the southern corner (EPA, 1988).

There is little surface run-on or run-off at the site because of existing topographic restraints and man-made barriers, such as ditches or railroad cuts or embankments along site boundaries. Fisher Ditch runs west to east along the northern boundary of the BWP site. The Fisher Ditch Extension, a buried water pipeline, crosses the eastern portion of the property diagonally from northwest to southeast. The United Water Company's Rocky Mountain Ditch, also a buried culvert, crosses the extreme southern tip of the property. Ground water is present in a series of three water-bearing geologic units beneath the site. These three partially-saturated or saturated geologic units underlying the site are shown in Figure 3. In descending order they are:

1. Alluvial deposits and weathered Denver Formation bedrock (surficial aquifer);

2. The unweathered Denver Formation bedrock (Denver aquifer); and

3. The upper Arapahoe Formation (Arapahoe aquifer).

Surficial/Weathered Denver Aquifer. Ground water investigations revealed that the surficial/weathered Denver formations act as a single unconfined aquifer (referred to hereafter as the "surficial aquifer"). The surficial aquifer is a shallow, unconfined system composed of Pleistocene eolian sands and silts, sands and gravels of the Slocum terrace alluvium, and weathered Denver Formation claystone. The contact between the weathered and unweathered bedrock lies at depths ranging from 15 to 30 feet across the site. Flow in the surficial aquifer is to the north-northeast. The aquifer is recharged by surface infiltration, upgradient ground water, and Fisher Ditch. A number of shallow domestic and irrigation wells are located in this aquifer in the vicinity of the site. From recent well user surveys, the current use of these wells is apparently limited to non-domestic purposes.

Denver Aquifer. The underlying unweathered Denver Formation aquifer is confined and also has a north-northeast flow direction. The upper seven to 15 feet of the Denver Formation are weathered bedrock with vertical fracturing, which decreases with depth. The unweathered Denver Formation bedrock constitutes the confined Denver aquifer and is made up of claystone, shale and sandstone lenses. The unweathered bedrock is consolidated and only locally fractured. The weathered portion and the unweathered portion of the Denver Formation are treated as two separate hydrologic units with the upper, weatheredportion considered as part of the surficial aquifer (described above). The Denver aquifer under the Broderick property appears to contain lenses of permeable sandstone interbedded in less permeable claystone (see Figure 3). These lenses of sandstone generally do not have large areal extents, thereby providing only limited water supplies and confining contaminants to relatively small areas. Recharge occurs primarily by downward migration of water from the overlying surficial aquifer through vertical fractures. Some residences north of the site use Denver aquifer ground water wells for commercial and/or irrigation purposes.

Arapahoe Aquifer. The upper Arapahoe aquifer is also a confined system that is composed predominantly of loosely consolidated sands with some interbedded claystone and shale. This formation forms the major bedrock aquifer in the Denver Basin and lies at a depth of approximately 200 feet below the surface. The regional dip of bedrock is gently toward the north-northeast. The ground water flow in the Arapahoe aquifer is generally to the north. The Arapahoe aquifer is confined by the overlying Denver aquifer. Recharge of the Arapahoe occurs at the outcrop areas around the edges of the Denver basin, approximately 15 to 20 miles south and west of the site. Several private wells in the immediate area tap the Arapahoe aquifer.

Nature and Extent of Contamination

The scope of the RI was directed at studies for all media that may have been contaminated. Soils, Fisher Ditch surface water and sediments, ground water, buildings, and vessel contents were investigated as potential pathways at the site. Some of these media were apparently affected by the migration of contaminants from former industrial activities at the impoundment area, process and drip track area, and the former railroad engine house/shop area (see Figure 2). Soils at the BWP site were found to have been affected by wood-treating chemicals (PCP, creosote), heavy metals (arsenic, lead, cadmium, zinc), and other wastes (fuel oil and grease). Fisher Ditch sediments were impacted by creosote-type polynuclear aromatic hydrocarbons (PAHs). Ground water was found to have been affected by wood-treating chemicals (pentachlorophenol, creosote, isopropyl ether) and volatile organic compounds (primarily fuel oil). This contamination is summarized below.

The estimated volumes of contaminated materials are given in the June 28, 1991 FS. These contaminated volumes above the NCP-required goal of 10^{6} include: 160,100 cubic yards of soils; 119 cubic yards of Fisher Ditch sediments; 600 cubic yards of metals-contaminated soils; 528 million gallons of ground water; and 42,000 gallons of contents from buildings, vessels, and drums on the Broderick property.

The primary contaminants of interest at the site are polynuclear aromatic hydrocarbons (PAHs), acid extractable compounds (principally PCP and other chlorinated phenolic compounds), dioxins and furans, volatile organic compounds (VOCs) (principally benzene, ethylbenzene, toluene and xylene), and some toxic metals (principally arsenic, cadmium, lead, and zinc).

Soil Contamination. Soil contamination at the site is found primarily in the impoundment and process areas to a depth of approximately 4 feet and consists primarily of PAHs and PCP. Metals contamination of surficial soils was noted in the former railroad shop area. Some PCP contamination was also identified along the eastern site boundary near the adjacent Koppers wood treating facility.

Some PAHs were detected at concentrations as high as 14,000 ppm in the surface soils in the impoundment area (see Table 1A). Concentrations of PCP were observed as high as 8,600 ppm in the surface soils in the impoundment area and as high as 3,300 ppm in the surface soils in the process area. Benzene was detected at a maximum of 0.33 ppm in the soil, while other VOCswere found at maximum concentrations of 21.4 ppm for xylenes, 4.7 ppm for toluene, and 4.3 ppm for ethylbenzene. The greatest concentrations of dioxins/furans were found in surface soils in the impoundment area, with TCDD equivalency values as high as 56 ppb. TCDD-equivalency means that the concentrations of the less potent isomers were multiplied by certain equivalency factors to express their relative strength compared to 2,3,7,8 TCDD, the most toxic form of dioxin (see Table A-1 in Exhibit A).

Ground Water Contamination. Wood treating chemicals (creosote and PCP) have been detected in the surficial and Denver aquifers (see Table 1B). Light non -aqueous phase liquid (LNAPL), often referred to as "floating product" or "floaters", is present as a sheen in most of the wells in the process and impoundment areas but is not believed to be off the Broderick property. Dense non-aqueous phase liquid (DNAPL), often referred to as "sinking product" or "sinkers", was detected in three wells on the Broderick property during the Phase II investigation.

The PCP-contaminant plume from the impoundment area has migrated off the Broderick property as far as the BFI-12 well. This well is approximately five hundred feet north of the BWP site, along Huron Street.

PCP and isopropyl ether (IPE) contamination have been found in the ground water along the eastern site boundary. This contamination is attributed to a plume migrating onto the BWP site from an adjacent wood-treating facility. This conclusion is supported by 1) the lack of use of IPE at BWP, 2) IPE was an important part of process operations at the adjacent facility, and 3) PCP has not been detected in any BWP wells between the eastern boundary and the process area.

Surface Water and Sediment Contamination. Surface water investigations revealed that contaminants do not leave the site through surface waterpathways. This is because the permeable nature of the surface soil allows most of the surface water to infiltrate, and wood treating compounds tend to adhere to surface and subsurface soil particles during infiltration.

Investigations of surface water in Fisher Ditch (which is used primarily for industrial and agricultural purposes) showed that the water flow in Fisher Ditch recharges the surficial aquifer along most of the northern boundary of the BWP property. Therefore, Fisher Ditch is not being impacted by contaminated ground water from the BWP site.

With the exception of one sample, contaminants were not detected in Fisher Ditch water. In this one sample, located at the eastern edge of the BWP site (sample # 89-45W), PAHs were detected at a concentration of 6.65 ppb (parts per billion).

Elevated concentrations of PAHs and oil and grease were noted in the Fisher Ditch berm and sediments. The source for the PAHs is uncertain since these PAH contaminants were also detected in samples slightly upstream of the BWP site.

Surface water in the seeps due north of the impoundments and immediately north of Fisher Ditch (see Figure 2) were contaminated with very low levels of PCP. The source may be the contaminant plume in the surficial aquifer, which has moved off the BWP property and extends slightly north of Fisher Ditch. Light-phase PAHs were also detected in this surface water, in the ditch berm, and in some of the sediments in the bottom of the ditch.

RI Conclusions

The final Phase III RI Report was completed on December 20, 1990. The report concluded that the highest concentrations of soils contaminated with wood-treating chemicals (creosote and PCP) and their by-products (dioxins and furans) occur in the impoundment and process areas and that only the Fisher Ditch sediment contamination has been found off the BWP site. A small amount of soil in the eastern portion of the BWP site is contaminated with heavy metals, apparently from industrial use of the site prior to its use for wood treating. Ground water in the surficial and Denver aquifers beneath the BWP site is contaminated with wood-treating chemicals and their by-products. The contaminated surficial ground water has moved at least 500 feet north of Fisher Ditch, which runs along the northern boundary of the BWP site. In addition, at several locations, non-aqueous phase liquids (NAPL) were found floating on the water table of the surficial aquifer or sinking into portions of the Denver aquifer. RI investigations detected very small amounts of PAH and PCP in one of the four wells in the Arapahoe aquifer. Approximately 42,000 gallons of wood-treating chemicals, fuel oil, contaminated water, and Freon were found to exist in tanks, drums, and buildings. Asbestos-containing building materials were also found in some of the buildings and drums.

VI. SUMMARY OF RISKS

As part of the Phase III RI/FS, a committee, comprised of the EPA Broderick team and BIC, prepared an Endangerment Assessment (EA) for the BWP site in January 1991. This EA was carried out to characterize, in the absence of remedial action (i.e., the "no-action" alternative), the current and potential future threats to human health and the environment. Figure 4 provides a glossary of the key risk terms from the EA that are used in this section.

Contaminants of Interest

The EA began by compiling a list of contaminants from the results of the various sampling activities that were measured to be above detection limits or above natural background levels. The quality of the data was then evaluated. Chemicals of interest were identified for the impoundment area, process area, and former railroad shop area. These chemicals were selected based on concentrations; toxicity; physical/chemical properties that affect transport/movement in air, soil, and water; and prevalence/persistence in these media. The identified chemicals included the potential contaminants of concern for human health and environmental risks at the site.

Exposure Assessment

Potential migration of contaminants at the Broderick site occurs from both the liquid and solid phases. Soils comprise the solid component and surface and ground water comprise the liquid component. The migration pathways for the contaminants from the impoundment area, process area, and former railroad shop area include:

- direct contact with contaminants remaining in the soil;
- leaching from subsurface soils into ground water;
- migration in ground water or surface water;
- release to the air through volatilization and fugitive dust emissions; and
- bioaccumulating in the food chain at the site.

Human intake of contaminants in soil and water at the site could occur through three routes of exposure: ingestion (i.e., swallowing), inhalation (i.e., breathing), and direct contact (i.e., touching). The EA considered inhalation of on-site air, including volatiles or fugitive dust, as one exposure pathway. The EA also evaluated the risk associated with ingestion of, or direct contact with, contaminants in the surface and subsurface soil and ground water. Potential human receptors considered in the EA for the three exposure pathways include the following:

Current Land Use Conditions

ù On-site Visitors

- Off-site Industrial Workers
- Off-site Residents (Adults, Children and Young Children[*]) <Footnote>* Children aged 3-15 years, Young Children aged 1-6 years (ages from EPA guidance)</footnote>
- Off-site Workers Maintaining Fisher Ditch
- Off-site Users of Fisher Ditch Water

Future Land Use Conditions

- On-site Construction Workers
- On-site Industrial Workers
- On-site Residents (Adults, Children and Young Children[*]) <Footnote>*

Children aged 3-15 years, Young Children aged 1-6 years (ages from EPA guidance)</footnote>

- On-site Day Care Children
- Off-site Industrial Workers
- Off-site Residents (Adults, Children and Young Children[*]) <Footnote>* Children aged 3-15 years, Young Children aged 1-6 years (ages from EPA guidance)</footnote>
- Off-site Workers Maintaining Fisher Ditch
- Off-site Users of Fisher Ditch Water

Estimates of current exposures to contaminants in soil and ground water are used to estimate whether adverse health effects could occur due to existing exposure conditions at the site. Estimates of future exposures are used to evaluate the potential that future adverse health effects may occur and include a qualitative estimate of the likelihood that such exposure would actually occur. The contaminant intake equations used for the EA and values chosen for various intake parameters are in accordance with the EPA Risk Assessment Guidance for Superfund (EPA/540/1-89/002, 1989). Exposure point concentrations in contaminated media (air, soil, and water) were estimated using site investigation data in conjunction with mathematical models. Details of the intake equations, parameters such as length of exposure, and mathematical models are provided in the EA. Intake assumptions were then combined with the exposure point concentrations to estimate intakes for each receptor scenario.

As can be seen in the list above, the EA considered both residential and industrial use of the site as viable potential future uses. In addition, for either of these future uses, a construction worker scenario was considered.

Toxicity Assessment

The purpose of the toxicity assessment was to weigh available evidence regarding the potential for chemicals of interest to cause adverse health effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a chemical and the increased likelihood or severity of the adverse effect. The toxicity assessment considered:

- types of adverse health effects associated with exposures to chemicals of interest;

- related uncertainties such as the weight of evidence of a particular chemical's carcinogenicity in humans; and

- the relationship between the magnitude of exposure and the adverse effects.

The toxicity assessment for the BWP site was accomplished in two steps: hazard identification and dose-response assessment. The first step, hazard identification, is the process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect. Hazard identification also involves characterizing the nature and strengthof the evidence of causation. The second step, dose-response evaluation, is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values were derived and used to estimate the incidence of adverse effects that may occur in humans at different exposure levels.

Qualitative weight-of-evidence classifications illustrate the varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. EPA's weight of evidence classification provides information which indicates the qualitative level of confidence or uncertainty in the carcinogenicity data obtained from studies in humans or experimental animals. The carcinogenic potential of a chemical is classified into one of the following groups, according to the weight-of-evidence from epidemiological and animal studies:

Group	Description
A	Human Carcinogen.
B	Probable Human Carcinogen:

B1 limited evidence of carcinogenicity in humans;

B2 sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.

C Possible Human Carcinogen - limited evidence of carcinogenicity in animals or lack of human data.

D Not Classifiable as to Human Carcinogenicity.

E Evidence of Noncarcinogenicity for Humans.

The summation of the risks associated with all potential carcinogens, which is done for each evaluated exposure pathway in the EA, may overestimate risk by including probable human carcinogens (Group B) with known human carcinogens (Class A). This conservative estimate of the potential carcinogenic risks prevents any potential underestimation. Chemicals in categories C and D are not considered as carcinogens in the EA.

Contaminants present in the affected media include PAHs, phenolics, dioxins/furans, volatile organics, and metals. These contaminant groups and some individual chemicals are described briefly in the following paragraphs. For more detailed toxicology information concerning these chemicals, see Exhibit A or the toxicology profiles for these contaminants presented in the EA.

Polynuclear Aromatic Hydrocarbons. Polynuclear aromatic hydrocarbons (PAHs) were detected in contaminated soils, sediments, and ground water at the site. PAHs are degraded by photodecomposition or biodegradation in surface soils, surface water, and the atmosphere. Generally, PAHs are readily metabolized by most plants and animals, and do not tend to bioaccumulate. In water, PAHs may either evaporate, disperse into the water column, become incorporated into bottom sediment, become assimilated by aquatic biota, or experience chemical oxidation and biodegradation.

The EA divided the PAHs into two categories:

- potentially carcinogenic and

- noncarcinogenic PAHs.

If there was any evidence of potential carcinogenicity in animals, the compound was classified as a potential carcinogen. The other compounds were classified as noncarcinogens. PAH absorption following oral and inhalation exposure is inferred from the demonstrated toxicity of PAHs following these routes of administration. PAHs are also absorbed following dermal exposure. Acute effects from direct contact with PAHs and related materials are limited primarily to phototoxicity; the primary effect is dermatitis. PAHs have also been shown to cause cytotoxicity in rapidly proliferating cells throughout the body, particularly in the hematopoietic system, lymphoid system, and testes.

Non-neoplastic lesions are seen in animals exposed to the more potent carcinogenic PAHs but only after exposure levels exceed those required to elicit a carinogenic response. Carcinogenic PAHs are believed to induce tumors both at the site of application and systemically. The chemicals of interest at the Broderick site include the following PAHs rated by EPA as B2 Probable Human Carcinogens: carbazole, chrysene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h) anthracene, indeno(1,2,3-cda)pyrene. The following PAHs are classified as

Class D (inadequate evidence of carcinogenicity) or are not classified by EPA: naphthalene, acenaphthylene, acenaphthene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

Acid Extractable Organics. The acid extractable family of phenol compounds have been found in the soils and ground water in the impoundment and process areas. The primary phenol present on the site is pentachlorophenol, also known as penta or PCP. PCP is moderately soluble in water and readily degrades by microbial, chemical and photochemical processes. PCP has also been shown to bioaccumulate in fish and other organisms. PCP and 2,4,6-trichlorophenol are classified as B2 - Probable Human Carcinogens. O-cresol (2-methylphenol) is classified as a C - Possible Human Carcinogen. Class D - Inadequate Evidence of Carcinogenicity - includes 4-methylphenol and phenol. Other acid extractables are found at the site that are not rated by EPA, including 2-chlorophenol, 2,4dichlorophenol, and 2,4,5-trichlorophenol.

Dioxins and Furans. Isomers of dioxins/furans have been detected in the soil and ground water at the Broderick site. However, only the heavier isomers of the dioxins/furans, such as penta, hexa, hepta and octa, weredetected. These compounds degrade very slowly by dechlorination, biodegradation, and photodegradation. The most potent isomer, 2,3,7,8 tetrachloro dibenzodioxin (2,3,7,8 TCDD), has never been found in creosote or PCP manufactured in the U.S. (EPA, 1991) and was not detected in any medium at the BWP site. TCDD has been classified by EPA as a B2 - Probable Human Carcinogen. Concentrations of the less potent isomers must be multiplied by certain toxicity equivalency factors to express their relative risk compared to 2,3,7,8 TCDD. These equivalency factors are found in Exhibit A.

Volatile Organic Compounds. Benzene, xylenes, toluene, and ethylbenzene were found in small quantities in several areas of the site. These compounds, components of most petroleum hydrocarbon fuels, are less mobile in the ground water than in soil. Migration may be inhibited by preferential adsorption to the soil matrix as well as by biological degradation of adsorbed and dissolved residues. Benzene is classified as a Class A carcinogen - Human Carcinogen - which is readily absorbed through both oral and inhalation routes. The toxic effects of benzene in humans and other animals include central nervous system effects, hematological effects, and immune system depression. EPA has classified methylene chloride, trichloroethene (TCE), and trichloroethylene as B2 - Probable Human Carcinogens. EPA has classified tetrachloroethylene as a Group C - Possible Human Carcinogen. Toluene, ethylbenzene and xylene are categorized as Class D.

Metals. Potentially toxic metals have been detected in the soils near the long-demolished engine house area. Concentrations of these metals are relatively low and these metals are not generally very mobile in the type of environment found at the BWP site. The metals of concern at the site include arsenic, cadmium, lead, and zinc. Arsenic is classified by EPA as an A - Human Carcinogen, based on sufficient evidence that arsenic compounds areskin and lung carcinogens in humans. Cadmium is classified as a B1 Probable Human Carcinogen, based on evidence of lung cancer in smelter workers. Lead and most lead compounds are classified as B2 - Probable Human Carcinogens, resulting from sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans. Zinc is categorized as Class D.

Quantitative Indices of Toxicity

For carcinogens, the dose response relationship is expressed by cancer slope factors (CSF). These CSFs reflect a linear relationship between dose and cancer risk. These CSFs also assume that any exposure to a potential carcinogen poses a measurable risk above zero. Uncertainties in estimating cancer slope factors are compensated for by using the upper 95% confidence limit on the slope of the line relating dose to risk, which is estimated using mathematical models which extrapolate from high experimental doses on laboratory animals to the low levels of exposure anticipated for humans. The slope factor is characterized as an upper-bound estimate for a specific chemical, while the doseresponse assumptions used in the EA provide a rough but plausible estimate of the upper limit of the risk of cancer to humans at the Broderick site.

For both carcinogens and non-carcinogens, a chronic reference dose (RfD) is an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to occur without an appreciable risk of harmful non-carcinogenic effects during a person's lifetime. Uncertainty factors are used in calculating the RfD, which reflect scientific judgement regarding the various types of data used to estimate the RfD.

The oral and inhalation quantitative indices of toxicity for the contaminants of interest are summarized in Table 2. The table summarizes the RfD and CSFs, where available, for each contaminant. Several compounds, including acenaphthylene, phenanthrene, and lead do not have quantitativetoxicity indices available. In accordance with the Risk Assessment Guidance (EPA, 1989), these compounds were evaluated on a qualitative basis. The EPA interim guidance on establishing soil cleanup levels for lead was used in the EA.

Risk Characterization

The EA evaluated the potential noncarcinogenic and carcinogenic risks posed by the contaminants in the various environmental media (i.e., soil, ground water, etc.) at the Broderick site. Carcinogenic risk is presented as a probability value (i.e., the excess chance of contracting cancer over a lifetime).

Carcinogenic Risk. Carcinogenic risk was estimated by multiplying the calculated intake of a contaminant by its CSF. A summary of the carcinogenic effects for the most impacted future use scenarios is provided in Table 4. (The EA presents a complete, detailed analysis for all future use scenarios and potential receptors at the site.) Based on this summary, the total carcinogenic risk for the various scenarios ranges from 10[-2] to 10[-8] for ground water, 10[-3] to 10[-12] for surface soils, and 10[-5] to 10[-12] for subsurface soils. The carcinogenic risk for many of the scenarios exceeds the 10[-4] to 10[-6] risk range specified in the NCP. Risk values calculated for ingestion and direct contact exposure pathways for the on-site surficial ground water are higher than risk values that were calculated for any other affected environmental medium. Therefore, using these values from the EA, the FS recommended the remediation of organics- and metals-contaminated surface and subsurface soils on the Broderick property and surficial aquifer ground water on and off the Broderick property.

Non-Carcinogenic Risk. The ratio of estimated intake to the chronic RfD was computed for each contaminant and the sum of the resulting ratios (referred to as hazard quotients) of each chemical of interest give the chronic (or noncarcinogenic) hazard index for each pathway. Chronic hazardindices were calculated for each exposure pathway of concern in each

scenario. Chronic Hazard Indices are shown in Table 5 for the two most impacted populations. Results indicated that some chronic hazard indices do exceed unity; therefore, EPA believes that there is a noncarcinogenic public health threat associated with soils and ground water on the Broderick property, based on the scenarios used in the EA.

Environmental Risks

The NCP requires that the EA evaluate potential threats to both human health and the environment. In the environmental risk analysis prepared as part of the EA, no endangered or economically important species and no critical habitats were identified at or near the Broderick site. The ecosystem types that were identified as potentially exposed in the EA are freshwater aquatic and terrestrial organisms. The EA evaluated direct contact such as dermal contact and ingestion of contaminated media, and indirect exposure by ingestion of contaminated organisms and bioaccumulation of contaminants up the food chain as the primary environmental exposure pathways.

The areas along Fisher Ditch and the Terrace area were identified in the EA as potential ecological receptors. Leaching to ground water and the subsequent ground water migration and discharge to seeps off the Broderick property is the probable migration pathway for the PAH contaminants found in these areas.

The impoundments, which contained PAHs and PCP, were determined to have been a primary contaminant source area. However, the removal and storage of the impoundment sludges as part of the OU 1 interim action has reduced the primary environmental risk from the impoundments. The removal of the sludges for off-site recycling during the OU 1 RA should completely eliminate this environmental risk. Migration of contaminants from media already affected by the impoundments continues to be a minor concern, although risks are in the acceptable range for all contaminants except some PAH contamination in Fisher Ditch sediments (for further discussion and maps showing the locations of these sediments, see the June 28, 1991 Feasibility Study). For this reason, some Fisher Ditch sediments will need to be excavated and treated to mitigate this environmental risk.

Conclusions from the Endangerment Assessment

Actual or threatened releases of hazardous wastes from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

As discussed in the sections on Risk Characterization, there are several environmental media for which the risk to primary impacted populations exceeds the 10^{-4} to 10^{-6} risk range. These include inhalation and ingestion of soils and ingestion of ground water by on-site resident young children, industrial workers, and construction workers. The chemicals of probable concern for the impoundment and process areas include PAHs, PCP, dioxins and furans, and, in the engine house area, toxic heavy metals, such as arsenic, cadmium, lead, and zinc. For this reason, the Feasibility Study (FS), which followed the Endangerment Assessment, evaluated the location and quantities of contaminated materials on the Broderick site.

As stated in the Environmental Risks section, some PAH contamination also exists in Fisher Ditch sediments. For this reason, some Fisher Ditch sediments will also need to be excavated and treated to mitigate this environmental risk. This treatment was also evaluated in the FS.

As one step in the evaluation of potential carcinogenic health effects, a "focused risk assessment" was included in the EA. The focused risk assessment estimated risks for the highest risk populations associated with potential exposure to "hot spots". These hot spots represent discrete areas of high contamination in each of the five areas of the site shown on Figure 2 for soils and each of the three aquifers shown on Figure 3 for ground water. The migration pathways included on-site surface soil, on-site subsurface soil, on-site ground water, and off-site ground water. This focused assessment represents the highest exposure possible from the contamination within the Broderick site. Results of the focused assessmen specifically for media in the impoundment area, process and drip track area, railroad shop, storage area, and low-use area are provided in Table 3.

VII. DESCRIPTION OF ALTERNATIVES

A feasibility study was conducted to develop and evaluate remedial alternatives for OU 2 at the BWP site. The final Phase III feasibility study (FS) for OU 2 was completed on June 28, 1991, and an Addendum to this FS was completed on July 11, 1991.

Remedial alternatives for each contaminated media were assembled from applicable remedial process technology options and were screened for effectiveness, implementability, and cost. The FS identified three remedial alternatives for soils/sediments contaminated with organics, three remedial alternatives for the contaminated surficial ground water, and one remedial alternative each for metals-contaminated soil, Denver aquifer ground water, Arapahoe aquifer ground water, and buildings, vessels and their contents which passed this initial screening.

The alternatives passing the initial screening were then evaluated in detail based on the nine criteria required by the NCP. For purposes of the detailed analysis, the FS combined the remedial alternatives for each media into combinations of detailed alternatives so that all contaminated media were addressed by each detailed alternative. This resulted in nine detailed alternatives, that is, three soil/sediments remedial alternatives times three surficial ground water remedial alternatives plus "common elements". The "common elements" were made up of the remedial alternatives for the media which had a single remedial alternative at the conclusion of the screening stage of the FS. In addition, the FS considered a no-action alternative in the detailed analysis. The NCP requires that a no-action alternative be included to provide a baseline for comparison of the other alternatives. Therefore, 10 detailed alternatives were analyzed in the FS. This same breakdown of alternatives was used in the Proposed Plan.

In order to simplify the analysis for this ROD, EPA has decided to alter the approach used in the FS and Proposed Plan. Instead of combining the remedial alternatives for each major media into detailed alternatives, the remedial alternatives for each media will be presented and analyzed separately. The three major media groups are soils and sediments, ground water, and buildings, vessels, and their contents. The discussions will present remedial alternatives for each media as well as the common elements for that media. The chosen remedial alternatives for each media will then be combined in Section IX, below, to provide the final site remedy. Table 6 has been included to provide a link between the discussion below and the discussion of detailed alternatives in the FS and the Proposed Plan.

The remedial alternatives for soils and sediments are described first, ground water remedial alternatives are described second, and remedial alternatives for building, vessels, and their contents are described third.

Remedial Alternatives for Soils and Sediments

Two distinct groups of contaminated soils were discovered at the site. The first group is the organics-contaminated soils and sediments. Organics-contaminated soils and sediments make up the vast majority of the contaminated soils at the site. The second group is the heavy metals-contaminated soils. The screening and detailed analysis of remedial alternatives in the FS resulted in the identification of three remedial alternatives for the organics-contaminated soils and sediments. Two of the four remedial alternatives below, Alternative 2, Thermal Desorption, and Alternative 4, Ex-Situ Bioremediation, were analyzed in detail under two different action levels, i.e., 10[-4] and 10[-5]. No alternatives were analyzed in detail for the 10[-6] action level. Technologies that could reach the 10[-6] action level were determined not to be cost effective during the FS screening. Under the 10[-4] action level, contaminated soils would be excavated such that residual cancer risks in the unexcavated soils would be at or below the 10[4] level. Under the 10[-5] action level contaminated soils would be excavated such that residual cancer risks in the unexcavated soils would be at or below the 10[-5] level. Thus, the volume of soils excavated under 10[-5] would be greater than under 10[-4]. To simplify the description and comparison of alternatives, alternatives are presented only in this and the following section assuming a 10[-5] action level. For a detailed analysis and comparison of the two action levels, please refer to Section XI below.

EPA has determined, for the following reasons, that an action level for soils based on an industrial use scenario is appropriate for this site. The industrial use scenario is appropriate because the present land uses in the vicinity of the site are predominantly industrial and commercial. Industrial and commercial land uses have dominated the area around the site for the last 40 to 50 years. It is reasonable to assume that such uses will continue into the foreseeable future.

Table 7 lists the remedial alternatives considered for the organics-contaminated soils and sediments.

Screening in the FS left only one remedial alternative for the heavy metals-contaminated soils. This single remedial alternative is included as a common element of each of the soil/sediment alternatives described below (except no-action). Table 7 also presents a summary of the volume of contaminated material to be treated by each alternative, the present value costs, and period of treatment for each soils and sediments remedial alternative. Each alternative below contains a brief analysis of ARARs. All ARARs analyzed for the site can be found in the FS.

Soils and Sediments Alternative #1 - No-Action. In this alternative, an analysis of which is required by the NCP, no action would be taken to contain or treat the contaminated soils and sediments at the site. However, the completion of the OU 1 interim action would not be impacted by this alternative. The site was fenced and the impoundment sludges have been isolated in lined storage cells under the OU 1 ROD Amendment. These sludges would still be transported from the site to an off-site recycling facility under OU 1.

Because contaminated soils would remain in place and would contribute to ground water contamination, a no-action alternative would present longterm health risks both on and off the property. Short and long-term health risks would be present in exposure scenarios involving land development and/or industrial and construction activity. Leaching of contaminants into the underlying ground water would continue to present an environmental threat. Costs required to implement and maintain this alternative are assumed to be zero.

Soils and Sediments Alternative #2 - Thermal Desorption. In this alternative organics-contaminated soils and sediments would be excavated, oversized materials removed, and the soils moved to an on-site thermal desorption unit. The thermal desorption process would involve batch process heating of the contaminated soil to a temperature between 300 and 800 F, in order to drive the PAHs, PCP and Dioxins/Furans out of the soil. The vapors would either be condensed and recycled or sent into an afterburner unit that destroys the contaminants.

Approximately 120 cubic yards of organics-contaminated sediments from Fisher Ditch would be excavated and treated to remove water. After removal of water these sediments would be moved to the thermal desorption unit for treatment, along with the soils.

If the condenser were used, recovered PAHs and PCP would be transported to an off-site reclamation facility. Production and transportation of these hazardous wastes would be carried out in compliance with RCRA regulations.

Afterburner gases would be released into the atmosphere. These air emissions would be controlled to comply with any Federal or State air quality regulations identified as ARARs. During excavation of the soil before treatment, appropriate measures would be taken to control fugitive dust and to assure compliance with provisions of the Colorado Air Quality Control Act identified as ARARs.

A wide variety of organic constituents are amenable to treatment by thermal desorption. Desorption efficiencies for specific constituents may vary as a function of constituent vapor pressure, residence time, and treatment temperature. Removal efficiencies of 25 to 98 percent have been observed for PAHs and removals of 99.9 percent have been observed for volatile organic constituents such as benzene, toluene, and xylenes. For Dioxins/Furans, removal efficiencies greater than 90% have been observed. Field demonstration tests and full scale operational data indicate that well -operated thermal desorption systems can exceed the RCRA standards for hazardous waste incinerators and the treated waste can be sufficiently detoxified to enable it to be delisted.

After each batch of soil and sediment is heated, the treated soils/sediments would be removed from the unit and either placed in an on-site landfill constructed to meet all ARARs or transported to an off-site, permitted RCRA landfill. Landfilling of contaminated soils after treatment in the desorption unit would trigger the RCRA LDR standards for K001 wastes. The LDR requirements would be met through a Soil and Debris Treatability Variance. The Treatability Variance treatment level ranges or percent reduction ranges that thermal desorption would achieve for the constituents are:

K001 Constituents	Treatment Levels
Naphthalene	95-99% Reduction
Pentachlorophenol	90-99% Reduction
Phenanthrene	95-99% Reduction
Pyrene	95-99% Reduction
Toluene	.5-10 ppm
Xylenes (Total)	.5-10 ppm
Lead	99-99.9% Reduction

Community acceptability may be a significant issue with regard to thermal desorption of soil containing hazardous waste. Some opposition to incineration was expressed during the public comment period for Operable Unit 1 (removal/treatment/disposition of the impoundment sludges). It would be expected that similar opposition would be expressed for an on-site thermal desorption unit.

Design and construction of the thermal desorption unit would require one year. Following construction, the organics contaminated soil and sediment would be treated and landfilled over a seven-year period. Soil volumes for this option would be 59,000 cubic yards. The costs for this option would range from $31.8 million for on-site landfilling to $44.0 million for off-site landfilling. The cost for the excavation and dewatering of the Fisher Ditch sediments is estimated at $7,400.

This alternative would not be protective for residential uses of the property. Therefore, exposure and access to organics-contaminated soils remaining after treatment and to the treated soil landfilled on the property would be controlled by the use of deed restrictions or other institutional controls to prohibit non-industrial uses of the site. The cost to apply these restrictions is not currently known.

In addition to the organics contaminated soil and sediment, approximately 800 cubic yards of soils contaminated with heavy metals above RCRA Toxicity Characteristic levels would be treated. This soil would undergo chemical fixation using such stabilization compounds as cement or fly ash to form a chemically and mechanically stable material. Treatability studies would be conducted to determine the best stabilization compound for the wastes at the site.

The metals-contaminated soils would be excavated and then mixed with water and the fixation agents. The resultant product would be poured into forms. Once the material was solidified, the solid blocks would be removed from the forms and allowed to cure. After the blocks had cured, they would be transported to an off-site, RCRA Subtitle D-permitted landfill for disposal. LDR standards would apply to this action. The potential heavy metals found at the BWP site which have LDR treatment standards are arsenic (D004), cadmium (D006) and lead (D008). To meet the LDR standards, it would have to be shown that the stabilized soil was below Toxicity Characteristic levels for these metals. The cost for stabilization and transportation is approximately $317,200.

The former sludge impoundments are RCRA interim status units. As such these impoundments must be closed in compliance with RCRA interim status regulations found in 40 CFR 265. The cost for this closure is estimated to be $283,400 (see Table 7). The total present worth cost, including capital and O&M costs, would be approximately $32,388,000. This alternative would be monitored continuously during operation. Because hazardous substances would be left on site above levels which would allow unlimited use and unrestricted exposure, the protectiveness of the remedy would be reviewed at least every five years as required by CERCLA.

Soils and Sediments Alternative 3 - In-Situ Bioremediation. This soil remediation technology would involve removing the oversized rocks from the natural, in-place soils. Then the soil would be periodically plowed and/or disced, fertilized, and irrigated using common farm implements. This process, commonly called "land farming", is done in order to maintain the moisture, nutrients, and aeration required to promote rapid growth of soil bacteria. These microscopic bacteria occur naturally in the soil at the site and grow using hydrocarbon contaminants as a "food" source. The ultimate goal of this process would be to break contaminants down into simpler, less toxic materials, such as simpler, non-chlorinated hydrocarbon compounds, then to organic carbon and water. The remedy would be designed, operated, and closed in compliance with RCRA land treatment requirements.

Approximately 120 cubic yards of organics-contaminated sediments from Fisher Ditch would be excavated and treated to remove water. After removal of water, these sediments would be spread within the area to be land farmed for treatment. No LDRs apply to placement of these sediments because the level ofcontamination is already below LDR standards.

Depending on the permeability of the subsoils, the leachate from the "farming" process may drive the contamination downward toward the water table through infiltration and percolation prior to complete biodegradation. RCRA land treatment regulations, identified as ARARs for this alternative, would require a monitoring program to detect migration of contaminants. This monitoring system may include lysimeters at the base of the treatment zone, or "zone of incorporation" to collect soil pore liquid, which together with soil cores taken at random locations, would be periodically collected and analyzed to determine removal efficiency and contaminant level. In addition, monitoring wells located upgradient and downgradient of the land farming area would be sampled periodically to determine the potential for migration of leachate.

Biodegradation of organic wood-treating wastes in a soils matrix has proven effective at hazardous waste locations throughout the country. Although fewer data are available for In-Situ Bioremediation at wood-treating sites than for Ex-Situ Bioremediation, the treatment processes are similar and InSitu Bioremediation has been successfully applied to remediation of fuel spills and other volatile organic compounds. At the Brainerd site in Minnesota, removal rates for total PAH have ranged from 70% to 90%. The major limiting factor is that In-Situ Bioremediation would not be feasible for treatment of subsurface soils since the maximum treatment depth is 12 to 24 inches with an optimal depth of 12 inches or less.

LDR standards do not apply to In-situ Bioremediation (in-place land farming) of the organics-contaminated soils and sediments because placement does not occur. It is expected that some K001 contaminated soils in the impoundment area would be moved in preparing the area for land farming. However, this would not trigger LDRs. The impoundment area is considered by EPA to be anarea of contamination (AOC). Movement of wastes within the AOC to prepare for land treatment is, by definition, not placement.

The land farming process would extend over a seven-year period (see Table 7). This alternative would be monitored continuously during operation. Because hazardous substances would be left on site above levels which would allow unlimited use and unrestricted exposure, the protectiveness of the remedy would be reviewed at least every five years as required by CERCLA. The volume to be treated is expected to be approximately 48,000 cubic yards. The costs for this option are estimated at $2.4 million.

The remedy proposed in this alternative would not be protective for residential uses of the property. Therefore, exposure and access to organicscontaminated soils, both treated and untreated, would be controlled by the use of deed restrictions or other institutional controls to prohibit future non-industrial uses of the property. The cost to apply these restrictions is not currently known.

Metals-contaminated soils would be remediated as provided above in Alternative 2. The costs for treating these soils are shown in Table 7.

The former sludge impoundments are RCRA interim status units. Since In-Situ Bioremediation would only treat contaminants in the top 12 to 24 inches, it is certain that waste residuals would be left in place. Therefore, RCRA interim status requirements for closure with wastes in place are ARARs for this alternative. As such, these impoundments must be closed in compliance with RCRA interim status regulations found in 40 CFR 265. The cost for this closure is estimated at $283,400 (see Table 7). The total present value cost for this remedial alternative, including capital and O&M costs, would be approximately $3,039,000.

Soils and Sediments Alternative #4 - Ex-Situ Bioremediation. Thisis EPA's preferred alternative for treatment of soils and sediments. This soil remediation technology would involve excavation and on-site biological treatment of organics-contaminated soils and sediments in a "land-treatment unit" (LTU). This LTU would be constructed by building earthen berms around the unit, then placing a synthetic liner and leachate collection and recovery system and a compacted filter material over the liner. The remediation process would include excavating the soil, separating the oversized rocks, and moving the soil to the LTU. Once placed into the LTU, the soils would be land farmed as in Alternative #3, above. The RCRA land treatment requirements, Subpart M, 40 CFR 264.270 to 264.283 are applicable to this alternative. The LTU would be designed, operated, and closed in compliance with these regulations. EPA is including, as extra protective measures, the liner and leachate collection system as well as closure with a multi-layered cap.

Approximately 120 cubic yards of organics-contaminated sediments from Fisher Ditch would be excavated and treated to remove water. After removal of water, these sediments would be placed in the LTU to be land farmed for treatment. No LDRs apply to placement of these sediments because the level of contamination is already below LDR standards.

Unlike Alternative #3, In-Situ Bioremediation, the leachate from this process would be isolated from the site subsoils by the liner and collected, treated, and reused in the treatment process. As in Alternative 3, lysimeters may be used below the liner to collect soil pore liquid, which together with soil cores taken at random locations within the land treatment unit soils, would be periodically collected and analyzed to determine removal efficiency and contaminant levels. Monitoring would be conducted in accordance with the requirements of the land treatment regulations and the general RCRA monitoring requirements of 40 CFR 264, Subpart F. This process would becapable of treating contaminated subsoils, as well as the upper 12 inches of surface soil.

Bench-scale tests conducted for the Broderick site (RI, 1990) have indicated that bioremediation is a viable approach, especially for reducing PAH concentrations. Removal efficiencies of 98% for PAHs, 70% for PCP, and 100% for volatile organic compounds were demonstrated for the Broderick soils. Recent studies by the USDA Wood Products Laboratory in Wisconsin have shown degradation of greater than 90% for PCP. Successful land treatment was demonstrated at the Koppers Feather River site in California, with removal of some of the heavy dioxin/furan compounds to levels exceeding 90% (FS, 1991, Appendix C). In addition, at a site in Libby, Montana, which is very similar to the Broderick site, a full-scale LTU has been pilot tested and is currently operational. Finally, pilot studies of the land treatment unit will be conducted at the Broderick site at the initial stages of the RA phase to better define removal rates and efficiencies and to optimize the addition of nutrients and water.

Excavation and placement of the contaminated soils into the LTU would trigger the RCRA LDR standards for the K001 wastes from the impoundments. These LDR treatment standards would not be met at the time of placement in the LTU. Therefore, EPA would invoke a temporary waiver of the LDR treatment standards through an interim action waiver. At the completion of the remedial action, the LDR requirements would be met through the Soil and Debris Treatability Variance.

The Treatability Variance treatment level ranges and percent reduction ranges that Ex-situ Bioremediation would attain for the constituents are:

K001 Constituents	Treatment Levels
Naphthalene	95-99% Reduction
Pentachlorophenol	90-99% Reduction
Phenanthrene	95-99% Reduction
Pyrene	95-99% Reduction
Toluene	0.5-10 ppm
Xylenes (Total)	0.5-10 ppm
Lead	99-99.9% Reduction

The treated soil would remain in the LTU following treatment and the LTU would be closed in accordance with the RCRA land treatment requirements and general RCRA closure requirements.

The remedy proposed in this alternative would not be protective for residential uses of the property. Therefore, exposure and access to organicscontaminated soils, both treated and untreated, would be controlled by the use of deed restrictions or other institutional controls to prohibit nonindustrial uses of the site. The cost to apply these restrictions is not currently known.

The treatment process would extend over a seven-year period. This alternative would be monitored continuously during operation. Because hazardous substances above health-based levels would be left on the property, the protectiveness of the remedy would be reviewed at least every five years as required by CERCLA. The volume to be treated is expected to be approximately 59,000 cubic yards. The estimated costs for this option are $3.9 million (see Table 7).

Metals-contaminated soils would be remediated as provided in Alternative # 2 and #3, above. The costs for this remediation are shown in Table 7.

The former sludge impoundments are RCRA interim status units. Although with Ex-Situ Bioremediation contaminants in the subsurface soils would be excavated and treated, it is still expected that waste residuals would be left in place in the impoundment area after treatment. Therefore, RCRA interim status requirements for closure with wastes in place are ARARs for this alternative. As such, these impoundments must be closed in compliance with RCRA interim status regulations found in 40 CFR 265.228 and Subpart G of 40 CFR 265. The cost for this closure is estimated at $283,400 (see Table 7). The total present value cost for this remedial alternative, including capital and O&Mcosts, would be approximately $4,493,000.

Remedial Alternatives for the Ground Water

Three distinct aquifers were identified under the site. These are the surficial aquifer, the Denver aquifer, and the Arapahoe aquifer. Only the surficial and Denver aquifers were found to have contaminants above levels of concern. The screening of remedial alternatives in the FS resulted in the identification of three alternatives for the surficial aquifer and one alternative for the Denver aquifer. Table 8 lists the ground water alternatives for the surficial aquifer. The single alternative for the Denver aquifer is included as a common element of each of the surficial aquifer alternatives described below. Table 8 also presents a summary of the present worth costs for each of the remedial alternatives. Each alternative below presents a brief analysis of ARARs. A list of all ARARs analyzed for the site can be found in the FS.

Ground Water Alternative #1 - No-Action. In this alternative, an analysis of which is required by the NCP, no action would be taken to contain or treat the contaminated surficial ground water at the site. However, the completion of the OU 1 interim action would not be impacted by this alternative. The site was fenced and the impoundment sludges have been isolated in lined storage cells under the OU 1 ROD Amendment. These sludges would still be transported from the site to an off-site recycling facility under OU 1.

Because ground water contamination would remain untreated on the property and could continue to migrate off the property, a no-action alternative would present long-term health risks both on and off the property. Leaching of contaminants into the surficial ground water and continued migration of surficial contamination both off the property and into the underlying Denver aquifer would also continue to present an environmental threat. Chemical-specific ARARs would not be met for either the surficial or Denver aquifers and any reduction in toxicity, mobility, or volume of the contamination would occur only very slowly (hundreds to millions of years) due to natural degradation. Costs required to implement and maintain this alternative are assumed to be zero.

Ground Water Alternative #2 - Monitoring/Institutional Controls. In this alternative, ground water monitoring would be conducted periodically for a minimum of thirty years in all three aquifers at wells on and off the property to assess ground water quality and migration of contaminants. The specific details of this monitoring program would be developed during remedial design. However, it has been assumed for estimating costs that approximately 15 monitoring wells would be utilized for this purpose. Samples of water from these wells would be collected at regular intervals. Laboratory measured contaminant concentrations from these samples would be used to update the prediction of migration patterns and impacts on well owners north of the property. The chemical parameters to be monitored include total carcinogenic PAHs, pentachlorophenol, and dioxins and furans.

EPA has determined that it is technically impracticable to actively remediate the Denver aquifer due to its hydrogeologic characteristics. The Denver aquifer under the Broderick property is made up of small lenses of permeable sandstones interbedded in near-impermeable claystone which significantly limits the ability to pump and treat the contaminated ground water. Due to the small areal extent of the permeable lenses, the contaminated ground water is believed to be confined to within a few hundred feet of the impoundments. Consequently, institutional controls and monitoring would be required for the Denver aquifer. Federal and state ground water standards identified as ARARs would not be met for the Denver aquifer. These ARARs would need to be waived for the Denver aquifer due to technical impracticability. If new information indicates that it is not technically impracticable to treat the Denver aquifer under the Broderick property, or if monitoring or other information shows that the remedy is not protective, EPA will reconsider the remedy chosen for this aquifer.

In addition, the ground water in the Arapahoe aquifer would be monitored to determine the level of contamination. This investigation would include the installation of new monitoring wells, completion of a constant discharge aquifer test, sampling the new and existing Arapahoe wells, and analyzing the samples in a laboratory. If contamination is found, the aquifer would continue to be monitored and appropriate measures would be taken.

Institutional controls would be applied to the future use of the ground water. Institutional controls might include deed restrictions, covenants, or acquisition of property rights. Deed restrictions could be placed on future uses of ground water on the Broderick property by the current owner to control access to the contaminated water in the surficial and Denver aquifers. In fact, the owners of the Broderick site have indicated that they would cooperate with placing deed restrictions or covenants on the property. However, placement of deed restrictions or other institutional controls outside of the BWP property are uncertain because the cooperation and assistance of offproperty owners would be necessary. This is due to the fact that no specific state or local government agency regulations are currently available to preclude the use of ground water that is off the BWP property. Despite the placement of deed restrictions or other institutional controls on the property and notifications to appropriate agencies and the public, it is conceivable that present or future property owners may develop and use contaminated ground water. Therefore, the long-term effectiveness of institutional controls alone would be questionable.

The potential reduction in toxicity, mobility, and volume ofcontaminants in this alternative are the same as those in the No-Action alternative. Short- and long-term health effects would also be the same as in the No-Action alternative. Federal and state ground water standards identified as ARARs would not be met under this alternative in the surficial aquifer. These ARARs could not be waived for the surficial aquifer since EPA has determined that there are technologies available that would clean the aquifer to ARARs within a reasonable time.

The estimated cost for a periodic monitoring program over a 30-year period is approximately $685,000, as shown in Table 8. The cost for the Arapahoe aquifer testing would be approximately $126,000. No costs have been currently calculated for institutional controls, so the purchase of wells or water rights outside the BWP property would constitute an additional cost item. The total present value cost for this alternative, which includes capital and O&M costs, would be approximately $812,000. Since contaminated ground water would remain on the site, five-year reviews would be conducted as required by CERCLA.

Ground Water Alternative #3 - Ex-Situ Bioremediation. This alternative would involve collection of 526 million gallons of ground water and light non-aqueous phase liquids (LNAPL) from the surficial aquifer in a series of subsurface drain trenches on the BWP property and a recovery well off the property. These trenches would be located in the areas of highest ground water contamination and would extend to sufficient depth to intersect the unweathered Denver Formation. This depth may range from approximately 20 to 35 feet, depending on the depth to bedrock. Most of this ground water and LNAPL would come from the surficial aquifer, although small amounts of dense non-aqueous phase liquids (DNAPL) and ground water would also be extracted from the Denver aquifer through existing monitoring wells and any new monitoring wells which may encounter DNAPL. An on-site water treatment plant would be constructed. This plant would be designed to first remove LNAPL and DNAPL from the ground water in an oil/water separator. These NAPLs would be reclaimed by placing them in tanks or drums, then shipping them to an off-site recycling facility. The plant would then treat the water in a two-stage, fixed-film bioreactor, similar to a common water treatment plant. The water would be batch processed in several large tanks using nutrients, aeration, heat, and mixing to provide an environment conducive to rapid bioremediation. Small quantities of the treated water would be used for the soil remediation processes and the remaining treated water would be reinjected into the surficial aquifer. This ground water treatment would substantially reduce organics in the ground water before each reinjection in compliance with RCRA section 3020.

Recent EPA studies of the effectiveness of ground water extraction systems in achieving chemical-specific goals found that ground water extraction is an effective remediation measure for some organic contaminants and can achieve significant removal of other contaminants. Since the water treatment plant technology has been used at refinery sites for many years, the actual treatment technology for the recovered water is well established. A treatment plant similar to the one proposed for the Broderick site is currently operating at the Libby Superfund site in Montana. Recent studies under the EPA Superfund Innovative Technology Evaluation (SITE) program have removed over 99% of PCP in treated ground water.

It is often difficult to predict the ultimate concentration to which contaminants in the aquifer may be reduced. The ground water models in Appendix B of the FS indicate relative cleanup times may be as short as 1.6 years and as long as 600,000 years for specific contaminants using this alternative. Thus, Federal and state ground water standards identified as ARARs would not be met under this alternative in the surficial aquifer within a reasonable time. A waiver is not available for the surficial aquifer since EPA believes that the ex-situ/in-situ alternative discussed below may clean the ground water to Federal and state standards within a reasonable time.

This alternative would use institutional controls on the property as set out in Alternative #2 during the implementation and operation of the remedy. Ground water in all three aquifers would also be periodically monitored for thirty years both on and off the Broderick property to assess ground water quality and migration of contaminants. The specific details of this monitoring program would be developed during Remedial Design, but would be similar to those described in Alternative 2 above. The cost for a periodic monitoring program over a 30-year period is approximately $685,000.

The Denver and Arapahoe Aquifers would specifically be addressed as provided in Ground water Alternative 2. Costs are shown in Table 8.

For cost purposes, the proposed treatment times for the volume of water discussed above includes one year for constructing the water treatment unit and approximately 10 years of operation. However, the system would actually be run until action levels are reached or until a decision is made to cease operation. Since contaminated ground water would remain on the site, five-year reviews would be conducted as required by CERCLA. The total present value cost for this remedial alternative, including capital and O&M costs, would be approximately $9,280,000.

Ground Water Alternative # 4 - Ex-Situ/In-Situ Bioremediation. This alternative is EPA's preferred alternative and would involve use of a two-phase (ex-situ and in-situ) biological water treatment process. Ground water would be recovered and treated in an above-ground water treatment plant as described in Alternative #3, above. After some of the treated water is diverted for soil treatment, the remaining treated water would be mixed with nutrients and an oxygenating chemical, such as hydrogen peroxide. This nutrient-rich water would be reinjected into the aquifer to stimulate bacterial growth in order to promote further breakdown of contamination within the surficial aquifer. Experience with this treatment process has been found to reduce PAHs by 97% and PCP by 95%. Therefore, ground water treatment would substantially reduce organics in the ground water before each reinjection in compliance with RCRA section 3020.

Ground water in all three aquifers would be periodically monitored as described in Alternative #3, above.

An in-situ treatment system similar to the one proposed for the Broderick site is currently operating at the Libby Superfund site in Montana. The advantage that this system has over the pump-and-treat system in Alternative 3 is the ability to both treat contaminants in the aquifer and to desorb contaminants from soil particles in the aquifer to allow their removal to the water treatment plant. Although it is often difficult to predict the ultimate concentration to which contaminants in the aquifer may be reduced, the ground water models in Appendix B of the FS indicate relative cleanup times may be as short as 11 days to as long as 10 years for specific chemical contaminants using this alternative. Even assuming that these values are based on simplified model parameters, this two to five order of magnitude difference in relative treatment times indicates this approach will achieve all ARARs in a reasonable period of time.

This alternative would use institutional controls on the property as set out in Ground Water Alternative #2.

The Denver and Arapahoe Aquifers would be addressed as discussed in Ground Water Alternative #2. Estimated costs are shown in Table 8.

The proposed treatment times for the volume of water discussedabove includes one year for constructing the water treatment unit and approximately 10 years of operation for cost purposes. However, the system would actually be run until action levels are reached or until a decision is made to cease operation. The total present value cost for this remedial alternative, including capital and O&M costs, would be approximately $10,460,000. Since contaminated ground water would remain on the site, five-year reviews would be conducted as required by CERCLA.

Remedial Alternatives for the Buildings, Vessels and Drums and Their Contents

BVD Alternative #1 - No Action. In this alternative, an analysis of which is required by the NCP, no action would be taken to address the buildings, vessels and drums (BVD) and their contents. Like the no action alternatives for the soils and sediments and ground water, the completion of the OU 1 interim action would not be impacted by this alternative.

Because the structures and their contents would be left in place, a no-action alternative would present long-term health and environmental risks through direct contact and/or leaching. Costs required to implement and maintain this alternative are assumed to be zero.

BVD Alternative #2 - Demolition and Reclamation. Under this alternative, the buildings would be demolished and the building debris temporarily stockpiled on the Broderick property. The process building contains asbestos contaminated materials. Demolition and disposal of these materials would be done in compliance with Federal and state regulations identified as ARARs including State Air Quality Regulation 8 and the National Emission Standard for Asbestos. An estimated 225 tons of scrap metal would be transported for disposal at an off-site recycling facility. An estimated 850 cubic yards of building debris and 205 cubic yards of asbestos-containing materials would be disposed in appropriate off-site, permitted landfills.

Significant quantities (an estimated 42,000 gallons) of organic liquids and sludges remain in the drums and vessels at the Broderick site. The vessel contents would be pumped or excavated, stored temporarily on the Broderick property in drums, and then transported to an off-site reclamation facility, along with the contents already in drums. This storage and transportation would require compliance with all RCRA hazardous waste generator and transporter requirements.

Approximately 9,500 gallons of contaminated water remain in building sumps and basements at the site. This includes some fire water contaminated with asbestos left from the process building fire in 1985. This water would be pumped, stabilized, drummed and transported to a RCRA-permitted landfill.

The time for demolition and removal of all building materials from the site is estimated at one year. The estimated total present worth cost for this remedial alternative would be $1,230,000 (see Table 9).

VII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

All of the remedial alternatives which passed the initial screening process were evaluated in detail in accordance with Section 300.430 (e)(9) of the NCP. The detailed analysis was conducted using the nine criteria identified in the NCP. The nine criteria are: 1) overall protection of human health and the environment; 2) compliance with applicable or relevant and appropriate requirements (ARARs); 3) reduction of toxicity, mobility, or volume through treatment; 4) long-term effectiveness and permanence; 5) short-term effectiveness; 6) implementability; 7) cost; 8) state acceptance, and 9) community acceptance.

Criteria 1 and 2 are threshold criteria which must be met by the selected remedial action. Criteria 3, 4, 5, 6 and 7 are balancing criteria. The final two criteria are modifying criteria used to evaluate the alternatives based on State and local concerns.

A discussion of the comparative analysis of alternatives for the soils and sediments is provided below followed by discussions of the comparative analysis of alternatives for groundwater of the surficial aquifer and the buildings, vessels and drums and their contents.

Soils and Sediments

Overall Protection of Human Health and the Environment. Overall protection of human health and the environment addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

All of the alternatives, except no-action, would provide protection of human health and the environment by eliminating, reducing, or controlling the risks identified for the contaminated soils on the site. Each of the soils/sediments alternatives would use treatment to eliminate or reduce the initial risks and use institutional controls to eliminate or control the residual risks.

Alternative 4, Ex-Situ Bioremediation, and Alternative 2, thermal desorption, would provide greater overall protection because surface and subsurface soils would be excavated and isolated in engineered containment structures after treatment. Alternative 3, In-situ Bioremediation, provides less protection, since it does not include an engineered containment structure and does not feasibly treat the subsurface soils.

Alternative 1, no-action, would not provide protection of human health, since the contaminated soils would remain in place and would continue to pose risks through ingestion, inhalation and dermal contact. In addition, leaching of contaminants into the underlying ground water would continue to present an environmental threat. Since this no-action alternative would not meet this threshold criterion, it is not included further in the comparative analysis.

Compliance with ARARs. Compliance with ARARs addresses whether a remedy will meet all applicable or relevant and appropriate Federal and state environmental laws and/or provide a basis for a waiver from any of these laws. ARARs are generally divided into chemical specific, action specific, and location specific requirements.

All ARARs identified for these alternatives would be met or a waiver would be available. Placement of the contaminated soil from the impoundment area into the LTU in Alternative 4, Ex-Situ Bioremediation, would trigger LDRs. This ARAR would not be met at the time of placement but would be met at the completion of the remedial action. Thus, this ARAR would be waived under an interim action waiver. LDR requirements would be met at the end of the remedial action through a soil and debris treatability variance.

Land farming in Alternatives 3 and 4 would be designed, operated and closed in compliance with the RCRA land treatment regulations in 40 CFR, Subpart M. As an additional measure of protectiveness in Alternative 4, Ex-Situ Bioremediation, a liner would be placed under the LTU to prevent leaching of contaminants from the LTU to the ground water.

Alternative 2, Thermal Desorption would be operated to comply with all federal and state air quality regulations identified as ARARs. Disposal of the soils after treatment in the thermal desorption unit would trigger LDRs. LDR requirements would be met for this alternative by use of a soil and debris treatability variance.

RCRA closure requirements for wastes left in place are ARARs for each alternative. Closure of the impoundments would be performedpursuant to these closure requirements.

Reduction of Toxicity, Mobility, or Volume Through Treatment. Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the site.

All alternatives significantly reduce the toxicity, mobility and volume (TMV) of the soils and sediments exceeding the action levels at the site. Studies for this and other wood treating sites have demonstrated potential treatment efficiencies for the destruction of PAH, PCP and dioxins/furans of 90% to 99% for Alternative 2, Thermal Desorption, and Alternative 4, Ex-Situ Bioremediation. Alternatives 2 and 4 decrease the potential for contaminant mobility through destruction and the use of engineered containment structures. Alternatives 2 and 4 would significantly reduce the volume of contaminants; however, the volume of contaminated soils would probably not be significantly reduced. Alternative 3 would not be expected to reduce TMV as significantly, since it would not include an engineered containment structure and would not feasibly treat the subsurface soils.

Long-term Effectiveness and Permanence. Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time. This criterion includes the consideration of residual risk and the adequacy and reliability of institutional controls.

Alternatives 2, Thermal Desorption, and Alternative 4, Ex-situ Bioremediation, would be expected to provide the greatest long-term effectiveness and permanence. Each of these alternatives would produce similar levels of contaminant reduction. The excavation and treatment of surface and subsurface soils in Alternatives 2 and 4 would reduce residual risk to the 10[-5] risk level based on an industrial-use scenario. This residual riskwould be further controlled by institutional controls on soils not excavated and treated. Residual risks for treated soils would be controlled through placement of the treated soils in engineered waste management units and institutional controls. Alternative 3, In-Situ Bioremediation, would be expected to provide a lesser degree of long-term effectiveness and permanence because subsurface soils below 12 inches would not be effectively treated and control of the greater residual risk would be more dependent on institutional controls. The effectiveness and reliability of institutional controls is considered less than engineered controls.

Short-term Effectiveness. Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

All the alternatives require disturbance of the contaminated soils. In-Situ Bioremediation would require the least disturbance and therefore presents the least short-term risks. Alternative 2, Thermal Desorption, presents the greatest short-term risks. This alternative would present the greatest threat of air emissions. Short term risks can be controlled or eliminated through proper construction techniques. All of the alternatives would require approximately the same amount of time to implement, approximately, seven years.

Implementability. Implementability refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution. It includes coordination of Federal, State, and local governments to clean up the site.

All alternatives are expected to be technically implementable. Inand Ex-Situ Bioremediation are relatively simple treatment technologies, are easy to construct and operate, and have been successfully implemented at other sites. Of the two, In-Situ Bioremediation is more easily implementable, since it does not require the construction of an LTU and does not involve subsurface soils. Thermal Desorption is a new and more complex technology and requires specialized equipment and knowledge which makes it more difficult to procure, construct and operate. In addition, air quality concerns in the Denver Metro Area may make it more difficult to implement the Thermal Desorption alternative.

Institutional controls for each alternative would entail deed restrictions on use of and access to the site. The implementation of such deed restrictions or other institutional controls would require the cooperation and approval of the site owners. The owners of the site have indicated they would cooperate in establishing any needed deed restrictions or institutional controls.

Cost. This criterion examines costs for each remedial alternative. For comparison, capital and annual O & M costs are used to calculate a present worth cost for each alternative.

The total present worth costs for each soils/sediments alternative would be as follows:

Alternative 2 - Thermal Desorption	$32,388,000
Alternative 3 - In-situ Bioremediation	$ 3,039,000
Alternative 4 - Ex-situ Bioremediation	$ 4,493,000

State Acceptance. This criterion addresses the State of Colorado's response to the alternatives described in the proposed plan.

The State of Colorado has concurred with EPA's preferred alternative: Alternative 4, Ex-Situ Bioremediation.

Community Acceptance. This criterion addresses the public's general response to the alternatives described in the proposed plan.

The general public neither supported nor opposed EPA's preferred alternative: Alternative 4, Ex-Situ Bioremediation. The Potentially Responsible Party (PRP), BIC, supported EPA's selection of Ex-Situ Bioremediation but opposed EPA's decision to excavate soils based on the 10[-5] action level. Specific comments submitted by the public during the public comment period and EPA responses to those comments are attached as part of the Responsiveness Summary.

Ground Water Treatment For The Surficial Aquifer

Overall Protection of Human Health and the Environment. The active remediation alternatives would be expected to provide adequate protection of human health and the environment by eliminating, reducing, or controlling the risks posed by contaminated ground water. Ex-Situ Bioremediation and Ex-situ/InSitu Bioremediation would eliminate or reduce the contaminant levels in the ground water in order to provide protectiveness. Ex-Situ/In-Situ Bioremediation would provide the greatest overall protectiveness by eliminating or reducing contaminant levels in a reasonable time. Ex-situ Bioremediation would eliminate or reduce contaminant levels, but not in a reasonable period of time (see discussion on ARARs below). Stand-alone Institutional controls may provide some protection to human health by limiting exposure, but they provide no environmental protection and will not ensure protection of human health.

Alternative 1, no-action, would not provide protection of human health, since the untreated ground water would pose risks through ingestion and dermal contact to people on and off the property. Also, the surficial aquifer contamination would continue to migrate to the underlying Denver aquifer and off the Broderick property. Since this no-action alternative would not meet this threshold criterion, it is not included further in the comparative analysis.

Compliance with ARARs. The Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) were identified as ARARs for this site. For standalone institutional controls, MCLs would be met only through natural attenuation. Ground water modeling for the surficial aquifer was conducted to determine the time it would take to reach MCLs for the ground water alternatives under ideal conditions. The model was used only to determine the relative effectiveness of the three alternatives. It showed that under ideal conditions it would take millions of years for the surficial aquifer to reach MCLs by natural attenuation. Thus, institutional controls alone would not meet MCLs within a reasonable time.

For Alternative 3, Ex-Situ Bioremediation, the model also determined that it would take an unreasonable number of years to reach MCLs (i.e., 661,000 years). Therefore, this alternative would not meet ARARs within a reasonable time. A waiver based on technical impracticability is not available for these ARARs because there is presently a practicable technology for remediating the surficial aquifer. Since Alternatives 2 and 3 do not meet this threshold criterion, they are included in the analysis below for comparison purposes only. These alternatives were not considered for selection purposes.

Only the combination of in-situ bioremediation and ex-situ bioremediation would be expected to meet all MCLs for the surficial aquifer. The model predicts that under ideal conditions, MCLs for the surficial aquifer may be met both on and off the Broderick property within 10 years.

MCLs are exceeded in the Denver aquifer under the site. Due to the hydrogeology of this aquifer beneath the BWP property, it was determined that there is no practicable technology currently available for remediating this aquifer. Thus, the MCLs as an ARAR for the Denver aquifer have been waived due to technical impracticability (see Ground water Alternative 2 in the Description of Alternatives section for more information).

Reduction of Toxicity, Mobility, or Volume (TMV). The Ex-Situ/InSitu Bioremediation alternative would be expected to substantially reduce toxicity, mobility and volume of contaminants in the surficial aquifer, since bioremediation (i.e., degradation) occurs both on the surface and within the surficial aquifer. The Ex-Situ Bioremediation alternative would also reduce TMV but it would require a much longer period of time since bioremediation occurs only on the surface. The institutional controls alternative would not reduce TMV through treatment.

Long-term Effectiveness and Permanence. The Ex-Situ/In-Situ Bioremediation alternative provides the greatest long-term effectiveness and permanence. This alternative is considered effective and permanent in that it degrades and/or destroys contaminants to acceptable levels within a reasonable timeframe. It is the only alternative expected to reduce residual risk to acceptable levels. The Ex-Situ Bioremediation alternative would degrade/destroy the contaminants, but not within a reasonable timeframe. Therefore, it is not adequately effective or permanent. Institutional controls would not provide long-term protection of human health and the environment.

Short-term Effectiveness. The Ex-Situ/In-Situ Bioremediation alternative is the most effective treatment alternative in the short-term. It is estimated that this response action could be completed (i.e., reach MCLs) in approximately 10 years under ideal conditions. The Ex-Situ Bioremediation alternative would require thousands of years to be effective. Institutional controls on the BWP property may provide an effective short-term remedy in that they may reduce the potential for human exposure immediately; however, the ability to implement institutional controls off the property is questionable. Construction of the extraction and treatment systems for Ex-situ and Ex-situ/In-situ Bioremediation would be identical except Ex-situ/In-situ would add the nutrient oxygen component. Therefore, these alternatives present similar short term risks during construction. Any risks presented by construction could be controlled or eliminated by proper construction and health and safety techniques. No construction is required for institutional controls.

Implementability. The two active treatment alternatives are expected to be easily implementable. Ex-situ/In-situ Bioremediation has been successfully implemented at a number of sites, one of which is very similar to the BWP site and can serve as a model (i.e., the Libby Superfund site). Of the two active treatment alternatives, the Ex-Situ Bioremediation alternative is slightly more implementable given that it does not require the construction of a nutrient component unit. The implementability of stand-alone institutional controls outside of the BWP property is questionable. This is due to uncertainties regarding the legal and/or administrative mechanisms for implementing and enforcing the controls. More information on institutional controls is provided in the Description of Alternatives section.

Cost. The total present worth costs for each ground water alternative are estimated as follows:

Alternative 2 - Institutional Controls	$ 812,000
Alternative 3 - Ex-situ Bioremediation	$ 9,280,000
Alternative 4 - In-situ/Ex-situ Bioremediation	$10,460,000

State Acceptance. The State of Colorado has concurred with the selection of Alternative 4, Ex-Situ/In-Situ Bioremediation, for the ground water.

Community Acceptance. The general public neither supported nor opposed EPA's selected remedy. The PRP, BIC, generally opposed the selected remedy and instead supported containment of the LNAPL and institutional controls/monitoring for the dissolved contamination in the ground water. Specific comments submitted by the public during the comment period, and EPA responses to those comments, are included with this remedy selection as part of the Responsiveness Summary. Buildings, Vessels and Drums and Their Contents

Overall Protection of Human Health and the Environment. Alternative 1, no-action, would not provide protection of human health, since the structures and their contents would be left in place and would pose risks through direct contact. Leaching of the contaminants to the ground water below would continue to present an environmental risk. Because this no-action alternative would not meet this threshold criterion, it is not included further in the analysis.

Alternative 2 would be protective of human health and the environment by reclamation of any useable components and disposal of the remaining components at a RCRA-permitted facility. Since Alternative 2 is the only active remedial alternative identified for the structures and their contents and would meet all ARARs, the comparative analysis is not continued further.

IX. SELECTED REMEDY

After consideration of the statutory requirements of CERCLA, the detailed analysis of the alternatives, and public comments, EPA has determined that the most appropriate remedy for the site is as follows:

Soils/sediments

-Ex-Situ Bioremediation for the organics contaminated soils (Soils Cleanup Alternative 4),
-Chemical fixation of the metals contaminated soils,
-Institutional Controls for the organics-contaminated soils remaining after treatment. -Closure of the former sludge impoundments

Ground water

-Ex-Situ/In-Situ Bioremediation and institutional controls for the surficial aquifer (Ground water Cleanup Alternative 4), -Institutional controls for the Denver aquifer, -Drilling of additional wells in the Arapahoe aquifer to further characterize the aquifer and contamination, if any, -Monitoring of the three aquifers. Structures and Their Contents

-Demolition and Disposal of buildings, vessels and drums to a RCRApermitted landfill, -Reclamation of scrap metal and contents, -Disposal of basement and sump water to a RCRA-permitted landfill.

Remedy for Soils/Sediments

The remedial alternative selected by EPA to remediate the soils and sediments is Alternative 4, Ex-situ Bioremediation. This soil remediation technology will involve excavation and on-site biological treatment of organicscontaminated soils and sediments in a "land-treatment unit" (LTU). This LTU will be constructed by building earthen berms around the unit, then placing a synthetic liner and leachate collection and recovery system and a compacted filter material over the liner. The remediation process will include excavating the soil, based on the action levels set out below in Table 11, separating the oversized rocks, and moving the soil to the LTU. Once placed into the LTU, the soils will be land farmed to meet the treatment levels set out in Table 12. The RCRA land treatment requirements, Subpart M, 40 CFR 264.270 to 264.283 are applicable to this alternative. The LTU will be designed, operated, and closed in compliance with these regulations. EPA is including, as extra protective measures, the liner and leachate collection system, as well as closure with a multi-layered cap.

Approximately 120 cubic yards of organics-contaminated sediments from Fisher Ditch will be excavated and treated to remove water. After removal of water, these sediments will be placed in the LTU for treatment. No LDRs apply to placement of these sediments because the level of contamination is already below LDR standards.

The leachate from this process will be isolated from the site subsoils by the liner and collected, treated, and reused in the treatment process. Lysimeters may be used below the liner to collect soil pore liquid, which together with soil cores taken at random locations within the land treatment unit soils, will be periodically collected and analyzed to determine removal efficiency and contaminant levels. In addition, monitoring will be conducted in accordance with the requirements of the land treatment regulations and the general RCRA monitoring requirements of 40 CFR 264 Subpart f. This process will be capable of treating contaminated sub-soils, as well as the upper 12 inches of surface soil.

Pilot studies of the land treatment unit will be conducted at the Broderick site at the initial stages of the RA phase to better define removal rates and efficiencies and to optimize the addition of nutrients and water.

Excavation and placement of the contaminated soils into the LTU will trigger the RCRA LDR standards for the K001 wastes from the impoundments. These LDR treatment standards will not be met at the time of placement in the LTU. Therefore, EPA will invoke a temporary waiver of the LDR treatment standards through an interim action waiver. At the completion of the remedial action, the LDR requirements will be met through a treatability variance for soil and debris. The treatability variance treatment level ranges or percent reduction ranges that Ex-situ Bioremediation will attain for the constituents are discussed later in this section and presented in Table 12.

The treated soil will remain in the LTU following treatment and the LTU will be closed in accordance with the RCRA land treatment requirements and general RCRA closure requirements.

The selected remedy will not be protective for residential uses of the site. Therefore, exposure and access to organics-contaminated soils, both treated and untreated, will be controlled by the use of deed restrictions or other institutional controls to prohibit non-industrial uses of the site. The cost of instituting these controls is not known at this time.

The treatment process in the LTU will extend over a seven-year period. This alternative will be monitored continuously during operation. Because hazardous substances would be left on the property, the protectiveness of the remedy would be reviewed at least every five years as required by CERCLA. The volume to be treated is expected to be approximately 59,000 cubic yards.

In addition to the organics contaminated soil and sediment, approximately 800 cubic yards of soils contaminated with heavy metals above RCRA Toxicity Characteristic levels will be treated. This soil will undergo chemical fixation using such stabilization compounds as cement or fly ash to form a chemically and mechanically stable material. Treatability studies will be conducted to determine the best stabilization compound for the wastes at the site.

The metals-contaminated soils will be excavated and then mixed with water and the fixation agents. The resultant product will be poured into forms. Once the material is solidified, the solid blocks will be removed from the forms and allowed to cure. After the blocks have cured, they will be transported to an off-site, RCRA Subtitle D-permitted landfill for disposal. LDR standards will apply to this action. The heavy metals which have LDR standards are arsenic (DOO4), cadmium (DOO6) and lead (DOO8). To meet the LDR standards, it will have to be shown that the stabilized soil is below Toxicity Characteristic levels. The LDR standards for these metals are presented in Table 12, below.

The former sludge impoundments are RCRA interim status units. Although with Ex-Situ Bioremediation contaminants in the subsurface soils will be excavated and treated, it is still expected that waste residuals will be left in place in the impoundment area after treatment. Therefore, RCRA interim status requirements for closure with wastes in place are ARARs for this alternative. As such, these impoundments must be closed in compliance with RCRA interim status regulations found in 40 CFR 265.228 and Subpart G of 40 CFR 265.

Remedy For The Surficial Aquifer Ground Water

The ground water remedial alternative selected by EPA to remediate contaminated ground water in the surficial aquifer is Alternative 4, Ex-situ/Insitu Bioremediation. This alternative will involve the collection of 526 million gallons of ground water and light non-aqueous phase liquids (LNAPL) from the surficial aquifer in a series of subsurface drain trenches on the BWP property and at least one recovery well off the property. These trenches will be located in the areas of highest ground water contamination and will extend to sufficient depth to intersect the unweathered Denver Formation. This depth may range from approximately 20 to 35 feet, depending on the depth to bedrock. Most of this ground water and LNAPL will come from the surficial aquifer, although small amounts of dense non-aqueous phase liquids (DNAPL) and ground water will also be extracted from the Denver aquifer through three existing monitoring wells and any new monitoring wells which encounter DNAPL.

An on-site water treatment plant will be constructed. This plant will be designed to first remove LNAPL and DNAPL from the ground water in an oil/water separator. These NAPLs will be reclaimed by placing them in tanks or drums, then shipping them to an off-site recycling facility. The plant will then treat the water in a two-stage, fixed-film bioreactor, similar to a common water treatment plant. The water will be batch processed in several large tanks using nutrients, aeration, heat, and mixing to provide an environment conducive to rapid bioremediation. Small quantities of the treated water will be used for the soil remediation processes and the remaining treated water will be reinjected into the surficial aquifer. This ground water treatment will substantially reduce organics in the ground water before eachreinjection in compliance with RCRA section 3020.

An in-situ treatment system similar to the one selected for the Broderick site is currently operating at the Libby Superfund site in Montana. The advantage that this system has over common pump-and-treat systems is the ability to both treat contaminants in the aquifer and to desorb contaminants from soil particles in the aquifer to allow their removal to the water treatment plant. Although it is often difficult to predict the ultimate concentration to which contaminants in the aquifer may be reduced, the ground water models in Appendix B of the FS indicate relative cleanup times may be as short as 11 days to as long as 10 years for specific chemical contaminants using this alternative. Even assuming that these values are based on simplified model parameters, the modeling indicates this approach will achieve all ARARs in a reasonable period of time.

Institutional controls will be applied to the future use of the ground water. Institutional controls might include deed restrictions, covenants, or acquisition of property rights. Deed restrictions or other institutional controls could be placed on future uses of ground water on the Broderick property by the current owner to control access to the contaminated water in the surficial and Denver Aquifers. In fact, the owners of the Broderick site have indicated that they would cooperate with placing deed restrictions or covenants on the property.

EPA has determined that it is technically impracticable to actively remediate the Denver aquifer due to its hydrogeologic characteristics. The Denver aquifer under the BWP property is made up of small lenses of permeable sandstones interbedded in near-impermeable claystone which significantly limits the ability to pump and treat the contaminated ground water. Due to the small areal extent of the permeable lenses, the contaminated ground water is confined to within a few hundred feet of the impoundments. Consequently, institutional controls and monitoring will be required for the Denver aquifer. Federal and state ground water standards identified as ARARs will not be met under this remedial alternative. These ARARs are being waived due to technical impracticability. If new information indicates that it is not technically impracticable to treat the Denver aquifer under the Broderick property, or if monitoring or other information shows that the remedy is not protective, EPA will reconsider the remedy chosen for this aquifer.

In addition, the ground water in the Arapahoe aquifer will be tested to determine the level of contamination. This investigation will include the installation of new monitoring wells, completion of a constant discharge aquifer test, sampling the new and existing Arapahoe wells, and analyzing the samples in a laboratory. If contamination is found, the aquifer will continue to be monitored and appropriate measures will be taken.

The selected remedy will include surficial ground water extraction and ex-situ/in-situ bioremediation for an estimated period of ten years, during which time the system's performance will be monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modifications may include any or all of the following:

- Discontinuing pumping in areas of the surficial aquifer where cleanup goals have been attained;

- Alternating pumping at locations to eliminate stagnation points;

- Pulse pumping to allow surficial aquifer equilibration and encourage adsorbed contaminants to partition into ground water;

- Installing additional extraction trenches or wells to facilitate or accelerate cleanup of the contaminant plumes.

The proposed treatment time for the volume of water discussed aboveincludes one year for constructing the water treatment unit and approximately 10 years of operation for cost purposes. Since contaminated ground water will remain on the site, five-year CERCLA reviews will be conducted by EPA.

Remedy for the Buildings, Vessels and Drums and Their Contents

The remedial alternative selected by EPA to address the buildings entails demolishing and temporarily stockpiling the debris on the site. Under this alternative, the buildings will be demolished and the building debris temporarily stockpiled on the Broderick property. The process building contains asbestos contaminated materials. Demolition and disposal of these materials will be done in compliance with Federal and state regulations identified as ARARs including State Air Quality Regulation 8 and the National Emission Standard for Asbestos. An estimated 225 tons of scrap metal will be transported for disposal at an off-site recycling facility. An estimated 850 cubic yards of building debris and 205 cubic yards of asbestos-containing materials will be disposed in appropriate off-site, permitted landfills.

Significant quantities (an estimated 42,000 gallons) of organic liquids and sludges remain in the drums and vessels at the Broderick site. The vessel contents will be pumped or excavated, stored temporarily on the Broderick property, and then transported to an off-site reclamation facility, along with the contents already in drums. This storage and transportation will require compliance with all RCRA hazardous waste generator and transporter requirements.

Approximately 9,500 gallons of contaminated water remain in building sumps and basements at the site. This includes some fire water contaminated with asbestos left from the process building fire in 1985. This water will be pumped, stabilized, drummed and transported to a RCRA-permitted landfill.

The time for demolition and removal of all building materials from the site is estimated at one year.

Cost Of The Remedy

Table 10 shows the detailed cost summary for the selected remedy as a whole. The total cost estimate for the remedy is $15.5 million. Some changes may be made to the remedy as a result of the remedial design and construction processes. Such changes, in general, reflect

modifications resulting from the engineering design process. For example, the amount of soils and sediments to be treated will depend on verification sampling, and the extent of the ground water extraction system for Ex-situ/In-Situ Bioremediation will depend on ground water sampling.

Remedial Action Objectives

The objectives of this remedial action are to: control present and future risks posed by direct contact to and/or ingestion of and/or inhalation of contaminated soils, sediments and ground water; to control the migration of contaminants from the soils to the aquifer systems; and, to prevent significant future human exposure to residual contamination in the soils and sediments and ground water. Other objectives are to remove and properly dispose of the buildings, vessels and drums and their contents including asbestos. The objectives will be met by attaining remedial action goals.

Remediation Goals and Action Levels for The Soils/Sediments

For soils and sediments the remedial goals is excavation and treatment so that the level of contaminants remaining in these materials poses no unacceptable risk to human health and the environment. Because the location, characteristics, and use of the site make its future use forresidences unlikely, action levels to be met by the remedial action for the soils and sediments were established using an industrial use scenario.

Determination of excavation and treatment standards for soils and sediments has been conducted using two methods: 1) Evaluation of the standards in various ARARs, such as BDAT concentrations in the Land Disposal Restrictions; and, 2) use of a human health risk assessment to determine contaminant concentrations which are protective of human health. Since the total Hazard Index using an industrial use scenario is below 1.00, non-carcinogenic health risks due to the soils are not indicated. Therefore, excavation and treatment standards are not required for the non-carcinogenic compounds in the soils and sediments. EPA has determined that the following action levels and treatment levels for the carcinogenic compounds are protective of human health and the environment and are in compliance with ARARs. The remediation activities for soils and sediments will be required to meet these levels.

Excavation of Soils/Sediments. Contaminated soils from the impoundment, process and surrounding areas will be excavated using a method that will ensure that a cumulative cancer risk level of 10[-5] is achieved in unexcavated soils. One such method applies health-based cleanup levels presented in Table 11, and uses "cleanup level indices (CLI)" as calculated by a formula described in Exhibit C for determining when excavation of soils is necessary. A CLI of less than one for a particular location indicates that the total cancer risk associated with all chemicals in the location is below the target risk level. If the CLI is one or greater in a particular location, then excavation will be required. The decision on the specific method to be used will be made when the sampling and analysis program is developed during remedial design.

Fisher Ditch sediments with concentrations of carbozole greater than the 23.2 mg/kg will be excavated and treated. This action level is based onecological risk factors.

Treatment Levels for Excavated Soils. Table 12 lists the treatment levels to be achieved in the LTU for the soils from the impoundment, process and surrounding areas. Benzo(a)pyrene and dibenzo(a,h)anthracene together represent 96% of the risk from the carcinogenic PAHs. Reducing the concentrations of these two PAH compounds to their treatment levels should reduce the total risk from the PAHs to or below the 10[-5] risk level for an industrial use scenario. Therefore, these two compounds are used as indicators for total PAH reduction. The 2,3,7,8-TCDD equivalent concentration incorporates all dioxins/furans found in the soils.

Ex-Situ Bioremediation of the organics-contaminated soils will comply with the LDRs through a treatability variance. The treatability variance treatment level ranges or percent reduction ranges (considered ARARs) that Ex-situ Bioremediation will attain for the K001 constituents are listed in Table 12. These treatment levels fall within the 10[-6] to 10[-7] risk range for an industrial use scenario.

LDR standards will apply to the metals-contaminated soils. To meet the LDR standards, it will have to be shown that the stabilized soil is below Toxicity Characteristic levels. These treatment levels are also listed in Table 12.

The treatment levels for the sediments will be the same as for the organics-contaminated soils.

The health risks of dioxins are presently being reassessed by the Office of Research and Development (ORD). If EPA's policy on dioxins changes due to this reassessment before or during the implementation of this remedy, the equivalency concentrations for dibenzo-p-dioxins and dibenzofurans combined will be changed accordingly.

Remediation Goals and Treatment Levels for the Surficial Ground Water

Remediation goals for the surficial ground water are: 1) restoring the contaminated ground water to a quality consistent with its potential future uses; 2) protecting uncontaminated ground water by minimizing the migration of contaminants within the ground water; and, 3) ensuring that the level of contaminants remaining in ground water poses no unacceptable risk to human health and the environment.

Ground water cleanup criteria to meet the remediation goals have been determined by examination and consideration of pre-established ARARs such as the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and the Colorado Basic Standards for Ground Water and the use of a human health risk assessment to determine contaminant concentrations which are protective of human health.

Table 13 lists the treatment levels for the surficial aquifer. EPA has determined that ground water treatment levels for carcinogenic compounds will be the following for the surficial aquifer: 1) total 2,3,7,8-TCDD equivalency concentrations for dioxins/furans will be reduced to no greater than 0.5 pg/L (picograms per liter); 2) trichloroethylene will be reduced to concentrations no greater than 5 micrograms per liter (ug/L); 3) tetrachloroethylene will be reduced to concentrations no greater than 1.6 ug/L; 4) carbozole will be reduced to concentrations no greater than 4.1 ug/L; and, 5) other organics, if detected, which may be present in the ground water will be reduced to the most stringent Federal or state standard identified as an ARAR or TBC. The total TCDD equivalent is a proposed MCL. The treatment level for trichloroethylene is a Colorado Basic Groundwater Standard. Although a Colorado Basic Standard applies, the more stringent risk-based level was selected for tetrachloroethylene. The treatment level for carbozole wasdetermined by risk analysis and corresponds to a 10^{-6} risk level.

EPA has also determined that groundwater treatment levels for noncarcinogenic compounds will be as listed in Table 13. All of these treatment levels, except for PCP, were determined by risk analysis and correspond to Hazard Quotients less than 1. The treatment level for PCP is a Proposed MCL identified as a TBC.

One of the goals of the ground water component of this remedial action is to restore the surficial ground water to a quality consistent with its beneficial use which is for domestic use. Based on information obtained during the remedial investigation, and the analysis of all

remedial alternatives, EPA and the Colorado Department of Health believe that the selected remedy will achieve this goal. However, ground water contamination may be especially persistent in the immediate vicinity of the source of contamination, where concentrations are relatively high. The ability to achieve cleanup levels at all points throughout the area of attainment, or plume, cannot be determined until the extraction system has been implemented, modified as necessary, and plume response monitored over time. If EPA determines that the selected remedy cannot meet the specified remediation levels at any or all of the monitoring points during implementation, modification of the remedy may be necessary.

Remediation Goals and Cleanup Criteria for the Buildings, Vessels and Drums and Their Contents

For the buildings, vessels and drums and their contents, the remedial goals are based on removal and/or recycling of the buildings, vessels and drums and their contents, so that they will no longer pose an unacceptable risk to human health and the environment.

Demolition and disposal of the buildings, vessels and drums and their contents will be done in compliance with Federal and State regulations identified as ARARs. Also, all asbestos ARARs will be met.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility under Superfund is to select remedial actions that are protective of human health and the environment. CERCLA also requires that the selected remedial action comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws, unless a waiver is granted. The selected remedy must also be costeffective and utilize permanent treatment technologies or resource recovery technologies to the maximum extent practicable. The statute also contains a preference for remedies that include treatment as a principal element. The following sections discuss how the selected remedy for the soils/sediments, ground water and structures and their contents meets these requirements.

Protection of Human Health and The Environment

The remedy selected for the organics-contaminated soils/sediments at the Broderick Wood Products site will protect human health and the environment by treating the soils/sediments using Ex-Situ Bioremediation to degrade and/or destroy and isolate the organic contaminants. The remedy will also chemically fix the metals-contaminated soils. Contaminant levels in the unexcavated organics-contaminated soils/sediments will be reduced to, or below the 10^{-5} cancer risk level based on the industrial use scenario. Contaminant level reductions in the LTU will be within 10^{-4} to 10^{-5} risk range. The risks in both the unexcavated soils/sediments and the LTU fall within the 10^{-4} to 10^{-6} risk range specified by the NCP. Following the remedial action, the hazard index for non-carcinogens will be less than one. The liner and leachate collection system for the LTU and closure of the LTU with a multilayered cap are extra precautionary measures and will minimize human exposure to any residual contaminants.

The remedy selected for ground water at the site will protect human health and the environment by reducing the levels of contaminants found in the surficial aquifer to Federal and state groundwater standards or risk-based levels found in Table 13. Restoration of the surficial ground water to these standards will ensure that ground water at the site will comply with the Safe Drinking Water Act and the Colorado Basic Standards for Groundwater, thereby providing protectiveness in the case of ingestion of or contact with the water. Although the surficial ground water is not currently believed to be used for drinking water purposes in the vicinity of the site, it is a potential drinking water source. Institutional controls will be required and implemented to the extent allowed by law for the surficial and Denver Aquifers. Institutional controls for the two aquifers will assist in reducing the possibility of human exposure to contaminated ground water. All three aquifers will be monitored for up to 30 years.

The remedy selected for the buildings, vessels and drums will protect human health and the environment by reclamation of any useable components and disposal of the remaining components at a RCRA-permitted facility.

Of the alternatives evaluated for cleaning up soils/sediments, ground water and structures and their contents, the selected remedy provides the best protection of human health and the environment. No unacceptable short-term risks or cross-media impacts will be caused by implementing this remedy.

Attainment of ARARs

All ARARs will be met upon completion of the selected remedy or a waiver will be available. Federal and State ARARs and to-be-considered (TBC) items for the selected remedy are presented in Exhibit B.

Chemical Specific ARARs. The selected remedy will comply with chemical-specific ARARs related to ground water and ambient air quality. The principal chemical-specific ARARs for the selected remedy are primary drinking water standards (MCLs) established under the Safe Drinking Water Act which are relevant and appropriate. MCLs have been designated for some contaminants at the site. MCLs have been proposed for other contaminants. Proposed MCLs are TBCs and will also be met. The Colorado Basic Standards for Ground Water are ARARs and will be met. These ground water ARARs and TBCs will be met in the surficial aquifer through implementation of the ground water extraction and treatment system. These ground water ARARs and TBCs will not be met in the Denver aquifer beneath the BWP property due to technical impracticability. Therefore, these ARARs are waived for the Denver aquifer by the signing of this ROD.

Action Specific ARARs. The selected remedy will comply with all action specific ARARs. Certain RCRA requirements have been found to be ARARs for the selected remedy. RCRA land disposal restrictions (LDRs) are applicable to portions of the selected remedy because soils contaminated with K001 wastes will be placed in the LTU in a manner that falls within the RCRA definition of "placement." Since LDR treatment standards for these K001 wastes will not be met upon placement in the LTU, the treatment requirement is temporarily waived using an interim measures waiver, granted through the signing of this ROD. The placement of these wastes will be followed by treatment with biodegradation. This treatment will comply with the LDRs for K001 waste through a soil and debris treatability variance also granted by the signing of this ROD. The interim measures waiver will not cause additional migration of contaminants, complicate the site response, present an immediate threat to public health or the environment, or interfere with or delay the final remedy.

LDRs are also applicable to metals-contaminated soils. These soils will be solidified to meet the LDRs.

RCRA requirements for land treatment facilities are applicable to the LTU. These requirements will be met in designing, operating and closing the LTU. Even though not required by the land treatment regulations, the LTU will include, as an extra precautionary measure, an impermeable bottom liner and multi-layer cap to prevent the migration of contaminants during and after treatment.

Closure of the RCRA interim status impoundments will occur during the CERCLA action. All RCRA closure requirements and monitoring requirements will be met and it is intended that formal RCRA closure will be accomplished simultaneously through coordination with RCRA authorities.

This alternative will comply with Federal and State air quality regulations during construction and implementation of the remedy.

RCRA section 3020 is applicable to the reinjection of treated ground water into the surficial aquifer. As required by RCRA section 3020, treatment before reinjection will substantially remove the contaminants from the water.

Location Specific ARARs. No location specific ARARs were identified for this site.

To Be Considered (TBCs). While not ARARs, TBCs should be considered with regard to designing, implementing, and operating the remedy. Proposed MCLs are TBCs for this action and will be met.

Cost Effectiveness

EPA believes the selected remedy is cost-effective in mitigating the principal risks posed by the soils/sediments, contaminated ground water and the structures and their contents within a reasonable period of time. Section 300.430(f)(ii)(D) of the NCP requires EPA to evaluate costeffectiveness by comparing all of the alternatives which meet the threshold criteria against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and, short-term effectiveness. The selected remedy meets these criteria and provides for overall effectiveness in proportion to its cost. The estimated cost for the selected remedy is $15,500,000.

The selected remedy for the soils provides the best overall effectiveness of all alternatives considered proportional to its cost. The selected remedy will greatly reduce the toxicity, mobility, and volume of soils exceeding the selected action levels. Also, the implementation of this remedy will result in long-term effectiveness by reducing residual carcinogenic risks to 10[-5], based on continued industrial use of the site, through permanent treatment. Alternative 2, Thermal Desorption, also provides high overall effectiveness, but Alternative 2 is much more expensive than the selected remedy. Although Alternative 3, In-Situ Bioremediation, is less expensive than the selected remedy, it does not provide as great a degree of long-term effectiveness or reduction in TMV through treatment.

The selected remedy for ground water provides the best overall effectiveness of all alternatives considered proportional to its cost. Alternatives 3, Ex -Situ Bioremediation, and 4, In-Situ/Ex-Situ Bioremediation, will both reduce the TMV of affected ground water and will be permanent solutions. However, Alternative 4 is the only alternative expected to reach MCLs within a reasonable time. Alternative 4 will reduce TMV more rapidly and will require less material handling and, therefore, has greater short-term effectiveness. Although the least expensive, Alternative 2, Institutional Controls, will not reduce TMV and will not provide long-term effectiveness and permanence.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

EPA believes the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Broderick site. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence; reduction in TMV achieved through treatment; short-term effectiveness; implementability; and cost, and also considering the statutory preference for treatment as a principal element and considering State and community acceptance. The following discussion of tradeoffs among remedial alternatives is divided into sections for soils/sediments and ground water.

Soils/sediments. For the alternatives for remediating the soils/sediments, the more critical evaluation criteria were: long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and, cost. Alternative 1, No-Action, is not considered since it would not meet the threshold criteria.

Alternatives 2, Thermal Desorption, and 4, Ex-situ Bioremediation, provide the greatest long-term effectiveness and permanence. Each of these alternatives produce similar levels of contaminant reduction. The excavation and treatment of surface and subsurface soils in Alternatives 2 and 4 reduce residual risk to the 10[-5] risk level based on an industrial-use scenario. The residual risk from soils not excavated and treated is controlled by institutional controls. Residual risks for treated soils are controlled through placement of the treated soils in engineered waste management units and institutional controls. Alternative 3, In-Situ Bioremediation, would provide a lesser degree of long-term effectiveness and permanence because subsurface soils below 12 inches would not be effectively treated resulting in a greater residualrisk due to untreated soils and control of this greater residual risk would be more dependent on institutional controls. The effectiveness and reliability of institutional controls is considered to be less than for engineered controls.

Studies on this and other wood-treating sites have demonstrated potential treatment efficiencies for the destruction of PAHs, PCP and dioxins/furans of 90% to 100% for the treatment processes in Remedial Alternatives 2 and 4. These alternatives also decrease the potential for contaminant mobility through engineering controls. Alternative 3 would be expected to provide similar destruction efficiencies in the top 12 inches. Sub-surface soils below 12 inches would not be treated, and therefore, the reduction of TMV would not be as great. Also, Alternative 3 would not include engineering controls.

Alternative 2 would be the most costly alternative ($32.388 million). At $4.493 million, Alternative 4 has the second highest cost. Despite a cost which is nearly an order of magnitude less than that for Alternative 2, Alternative 4 will achieve a similar level of cleanup. Alternative 3 would be the least costly ($3.039 million), but falls short with regard to long-term effectiveness and permanence and reduction of TMV.

Ground Water. For the remedial alternatives for the surficial aquifer, the critical evaluation criteria were the threshold criteria, overall protection of human health and the environment and compliance with ARARs. Alternative 1, No-Action, is not considered since it would not be protective of human health and the environment.

Ground water modeling for the surficial aquifer was conducted to determine the time it would take to reach MCLs for the ground water under ideal conditions. The model was used only to determine the relative effectiveness of the remedial alternatives. It predicted that, under ideal conditions, it would take millions of years for institutional controls (Alternative 2), which rely on natural attenuation, to reach MCLs. It also predicted that it would take thousands of years for Alternative 3 (Ex-Situ Bioremediation) to reach MCLs. Thus, these alternatives would not comply with ARARs, a threshold criterion, and Alternative 2 would not provide overall protection of human health and the environment. Consequently, these alternatives were eliminated from further selection consideration. Alternative 4, Ex-Situ/In-Situ Bioremediation, is the only alternative that meets the threshold criteria.

The State of Colorado concurs with the selected remedy. The Proposed Plan for the site was released for public comment on September 23, 1991. The Proposed Plan identified Ex-Situ Bioremediation for the soils/sediments and Ex-Situ/In-Situ Bioremediation for the surficial aquifer. EPA reviewed all written and verbal comments submitted during the public comment period which ended on November 22, 1991.

Preference for Treatment as a Principal Element

The selected remedial alternatives for remediation of the contaminated soils/sediments (Alternative 4, Ex-Situ Bioremediation), ground water (Alternative 4, Ex-Situ/In-Situ Bioremediation), and buildings, vessels and drums and their contents satisfy the statutory preference for remedies that employ treatment as a principal element. By treating contaminated soils/sediments and ground water, the selected remedy incorporates the use of treatment technologies. Two treatment technologies will be used for contaminants in the soils/sediments: bioremediation for the organics-contaminated soils, and solidification for the metalscontaminated soils. Contaminated ground water will be treated using Ex-situ/Insitu Bioremediation. Principal threats including the contents of the buildings, vessels and drums and NAPLs will be removed and recycled, thus eliminating the need for treatment. Thus, the selected remedy satisfies the statutory preference for remedies that employ treatment as a principalelement.

XI. EXPLANATION OF SIGNIFICANT CHANGES

The Proposed Plan for the Broderick site was released for public comment in September 1991. The Proposed Plan identified Alternative 4, ExSitu Bioremediation, for the contaminated soils and sediments, Alternative 4, Ex-Situ/In-Situ Bioremediation, for the surficial groundwater and Alternative 2 for the buildings, vessels, and drums as the preferred alternative. As noted above in the Description of Alternatives section, the presentation of the alternatives in this ROD differs from the presentation of the alternatives in the Proposed Plan. These presentation differences are explained above and will not be repeated fully here.

The Proposed Plan presented a cost and excavation volume, based on the 10[-4] action level, for all soil remedial alternatives, but only presented a cost and excavation volume for the 10[-5] action level for Ex-Situ Bioremediation. In the ROD, EPA has analyzed all soil remediation alternatives at the 10[-5] action level. This was done primarily to simplify the description and comparison of alternatives. In order to maintain continuity between the Proposed Plan and the ROD, the analysis and comparison of the soil remediation alternatives under the nine criteria for the 10[-4] and 10[-5] action levels is presented below.

Overall Protection of Human Health and the Environment. Both the 10[-4] and the 10[-5] alternatives would provide overall protection of human health and the environment because each alternative would reduce residual risk in the unexcavated soils to within the 10[-4] to 10[-6] risk range specified in the NCP. The 10[-5] alternatives would provide a greater degree of protection because of a greater degree of long term permanence and effectiveness and a greater reduction of toxicity and mobility of contaminants through treatment.

Compliance with ARARs. All of the soil alternatives under either action level would comply with all identified ARARs or would be waived.

Long-Term Permanence and Effectiveness. The 10[-5] alternatives would be expected to provide a greater degree of long-term permanence and effectiveness because the residual risk in unexcavated soils would be reduced to a lower level. The placement of the excavated soils in engineered structures for the Thermal Desorption and Ex-Situ Bioremediation would also increase long-term effectiveness and permanence at the 10[-5] level because there would be less reliance on institutional controls to prevent exposure to residual risks. In addition, these two alternatives would produce benefits for the overall remedy because containment and isolation of the contaminated soils in engineered containment structures eliminates a potential source for further contamination of the groundwater. The benefits of the engineered containment structures are increased by use of the 10[-5] action level because a greater volume of source material would be removed and isolated.

The treatment endpoint for each of the three treatment technologies is expected to be about the same. Therefore, reduction of residual risk through treatment would be expected to be greater for the 10[-5] alternatives because of the greater volume of soils which would be treated to a reduced contaminant level.

Reduction of Toxicity, Mobility, and Volume of Contaminants through Treatment. The 10[-5] alternatives would provide a greater reduction of toxicity and mobility of contaminants since a greater volume of soils would be treated.

Short-Term Effectiveness. The 10[-4] alternatives present less short-term risk because less soil would be excavated or treated. Less time would, therefore, be spent implementing the remedy. Short-term risk for any of the alternatives under either action level can be controlled or eliminated through proper construction and health and safety techniques.

Implementability. Each of the alternatives under either of the action levels would be fully implementable.

Cost.

	10[-4]	10[-5]
In-Situ Bioremediation -	$1.02 million	$ 2.43 million
Ex-Situ Bioremediation -	$1.81 million	$ 3.88 million
Thermal Desorption -	$8.96 million	$31.78 million

Cost figures for In-Situ Bioremediation under the 10[-5] action level were not calculated in the FS and have been subsequently calculated by EPA.

State Acceptance. The State supports using the 10[-5] action level but does not support the 10[-4] action level.

Community Acceptance. BIC has stated its preference for use of the 10[-4] action level. The community has not indicated a preference for either action level.

EPA's determination to utilize the 10[-5] action level was based on the results of the above analysis and comparison as well as the stated preference in the preamble of the NCP for remedies that reduce cancer risks as close to 10[-6] as possible. EPA has determined that the increased cost of implementing the 10[-5] action level for excavation is justified by the increase in longterm effectiveness and permanence both for soils and, as a result of greater source reduction, for ground water. In addition, the 10[-5] action level produces a greater reduction in the toxicity and mobility of contaminants through treatment. The only criteria which favored the 10[-4] action level were cost and short-term effectiveness. However, short-term effectiveness is not a significant factor in this case because short-term risks can be easily addressed. The cost difference between the two action levels under the selected remedy was not substantial. When considered in terms of the selected remedy for soils/sediments, the increase in cost of using the 10[-5] action level is accompanied by a proportional increase in overall effectiveness which results in the conclusion that use of the 10[-5] action level for the selected remedy is cost-effective.

Building Water

The selected remedy in the June 1988 ROD for OU1 provided that water in the building's basement and sumps would be used as quench water for the on-site incineration of the impoundment sludges. The incineration remedy was replaced by off-site reclamation of the sludges. As a result, EPA reproposed, in the Proposed Plan for OU2, that the basement and sump water be treated in the water treatment plant which was part of the preferred alternative. The UIC regulation, identified as an ARAR for the ground water portion of the selected remedy, prevents the basement and sump water from being treated and reinjected into the surficial aquifer. Instead, EPA will send this water offsite for disposal as a hazardous waste. This will require that the water be stabilized as required by RCRA. The stabilized material will be transported for disposal to a RCRA Subtitle C hazardous waste landfill. This change would be necessary regardless of the remedial alternative chosen as the selected remedy, except no action. This change will increase the cost by approximately $20,000.00.

XII. REFERENCES

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EXHIBIT A

TOXICOLOGY PROFILES FOR
CONTAMINANTS OF CONCERN

The following discussion comes from the toxicology profiles for these contaminants presented in the Endangerment Assessment. The following summaries provide information regarding the carcinogenicity, mutagenicity, reproductive effects, and acute toxicity, if available, for the carcinogenic and non-carcinogenic PAHs, PCP, dioxins and furans, and toxic metals:

ORGANIC CONTAMINANTS:

Potentially Carcinogenic PAHs

Carbazole. EPA has classified carbazole as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies.

Chrysene. EPA has classified chrysene as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. Carcinogenic effects were observed in mice following repeated dermal application. Chrysene is considered to have weak carcinogenic activity compared to benzo(a)pyrene and is reported to have mutagenic effects. No information concerning teratogenicity or reproductive effects is available.

Benzo(a)anthracene. EPA has classified benzo(a)anthracene as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. Evidence from animal studies indicates that this compound is carcinogenic in mice when administered orally and dermally. Neither acute nor chronic exposure produced significant toxic effect. No data was found regarding teratogenicity, mutagenicity, or reproductive effects.

Benzo(a)pyrene. EPA has classified benzo(a)pyrene as a B2 Probable Human Carcinogen based on limited evidence in humans and sufficient evidence of carcinogenicity from animal studies. Mouse studies show this compound to be a local and systemic carcinogen. Adequate data does not exist to assess the effects on humans of acute or chronic exposure. No teratogenicity or other reproductive effects have been observed in laboratory animals.

Benzo(b)fluoranthene. EPA has classified benzo(b) fluoranthene as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. Mouse skin painting studies show this compound to be a complete carcinogen. Adequate data does not exist to assess the effects on humans of acute or chronic exposure. No data are available on teratogenicity or other reproductive effects.

Benzo(k)fluoranthene. EPA has classified benzo(k) fluoranthene as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. No data are available regarding mutagenicity, teratogenicity, or reproductive effects.

Dibenzo(a,h)anthracene. EPA has classified dibenzo(a,h) anthracene as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and as an experimental carcinogen from animal studies. Neither acute nor chronic exposures produced significant toxic effect. Data are available regarding mutagenicity effects.

Indeno(1,2,3-cda)pyrene. EPA has classified indeno(1,2,3-cd)pyrene as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and positive evidence of carcinogenicity from animal studies. Mutagenicity data in laboratory animals are available.

Noncarcinogenic PAHs

Naphthalene. No data is available regarding the carcinogenicity of naphthalene to humans. This compound is generally considered noncarcinogenic in experimental animals. However, naphthalene is classified as a Class D Carcinogen - there is not adequate evidence of carcinogenicity. Teratogenic and reproductive effects of inhaled or ingested naphthalene are not well documented, however, phototoxic effects in humans and rabbits have resulted from ingestion. Oral administration of naphthalene in rabbits and rats has resulted in cataract formation. Limited information is available concerning acute and chronic toxicity effect to humans and experimental animals.

Acenaphthylene. There are no data available regarding the carcinogenicity, teratogenicity, or reproductive effects in humans or experimental animals.

Acenaphthene. There is no evidence suggesting carcinogenicity andlimited evidence of mutagenicity. Slight morphological changes in the liver and kidney of rats have been reported following oral exposure to acenaphthene. Acute and chronic effects of acenaphthene exposure to humans are poorly understood.

Fluorene. Inadequate studies exist to evaluate the carcinogenicity of this compound. Mixed results in mutagenicity testing exist. No data are available on the teratogenic or reproductive effects or chronic and acute toxicity.

Phenanthrene. Insufficient studies have been performed to evaluate the carcinogenicity of the compound, although it may be a weak initiator. The acute and chronic toxic effects are unknown. There is limited evidence of mutagenicity and no evidence of teratogenic or reproductive effects.

Anthracene. There is no evidence suggesting carcinogenicity in humans by the oral route. Anthracene exhibits mixed results in mutagenicity testing. There are no reports of teratogenic or reproductive effects due to exposure. Little information concerning acute and chronic effects is available.

Fluoranthene. There is no information concerning carcinogenicity in humans, but fluoranthene appears to posses potent carcinogenic activity in test animals. There is limited evidence of mutagenicity and no information regarding teratogenicity or reproductive effects. Sufficient data exists on chronic effects to allow the EPA to set a human health water quality criteria.

Pyrene. No data is available to assess carcinogenicity to humans, but this compound has not been found to be carcinogenic in animal studies. There is limited evidence of mutagenicity. Information on teratogenic or reproductive effects is not available.

Benzo(g,h,i)perylene. EPA has classified benzo(g,h,i) perylene as a noncarcinogenic PAH based on limited evidence of carcinogenicityfrom animal studies. Data are available regarding mutagenicity effects.

Acid Extractables

Phenol. Phenol is classified by the EPA as a Class D agent which implies there is not adequate evidence of carcinogenicity. Phenol is readily absorbed through the gut, by inhalation, and percutaneously. Data on mutagenicity are equivocal. Phenol does not appear to be teratogenic. Due to its relatively low volatility at room temperature, phenol generally does not constitute a serious respiratory hazard; upon direct contact, it is a skin hazard.

2-Chlorophenol. The EPA has stated that 2-chlorophenol has not been evaluated for evidence of human carcinogenic or chronic health effects.

2-Methylphenol. 2-Methylphenol (or o-cresol) is classified by the EPA in Class C - Possible Human Carcinogen, based on skin studies in laboratory animals. Experimental evidence indicates that 2-methylphenol is absorbed following ingestion, inhalation, and dermal exposure. Effects following acute exposure to 2-methylphenol include injury to the eyes, skin, liver, kidney, and vascular system.

4-Methylphenol. 4-Methylphenol is classified by the EPA in Class D agent which implies there is not adequate evidence of carcinogenicity. Experimental evidence indicates that 4-methylphenol is absorbed following ingestion, inhalation and dermal exposure. Effects following acute exposure to 4-methylphenol include muscular weakness, gastroenteric disturbances, severe depression, edema of the lungs, injury to the eyes, skin, liver, kidney, pancreas, spleen and vascular system, collapse and death.

2,4-Dichlorophenol. The EPA has stated that 2-4-dichlorophenol has not been evaluated for evidence of human carcinogenic or chronic health effects. Based on studies in laboratory animals, experimental evidence indicates that 2-4-dichlorophenol causes teratogenic and reproductive effectsfollowing chronic exposure

2,4,5-Trichlorophenol. The EPA has stated that 2,4,5trichlorophenol has not been evaluated for evidence of carcinogenic health effects. 2,4,5-trichlorophenol is classified by the EPA as a potential chronic health hazard based on evidence of oral effects from studies in laboratory animals. No experimental evidence is available for inhalation exposure.

2,4,6-Trichlorophenol. 2,4,6-trichlorophenol is classified by the EPA as a B2 - Probable Human Carcinogen, based on no human data and sufficient evidence from studies in laboratory animals. Experimental evidence indicates that is absorbed following ingestion and inhalation exposure. The EPA has stated that 2,4,6-trichlorophenol has not been evaluated for evidence of chronic health effects.

Pentachlorophenol. PCP is classified by the EPA as a Class B2 Probable Human Carcinogen. PCP is readily absorbed following oral and inhalation exposure; evidence from occupational studies indicates it is also absorbed following dermal exposure (EPA, 1984d). Case reports in humans via occupational exposure indicate the following effects of PCP; neurotoxicity, immune system effects, liver and kidney damage, and hematological disorders. Phototoxic effects associated with skeletal ossification, as well as maternal toxicity in rodents were observed.

Dioxins/Furans

The isomer 2, 3, 7, 8 TCDD is used as the reference compound to evaluate the toxicities of the polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. TCDD is demonstrated animal carcinogen following dermal and oral administration. Various investigations show a weak link between occupational and environmental exposures of 2, 3, 7, 8 TCDD and carcinogenicity in humans. The U.S. EPA classifies this compound as a Class B2 - Probable Human Carcinogen. Teratogenic effects were observed in rats. Evidence of teratogenicity to humans is weak. Both positive and negative results were obtained in mutagenicity tests indicating that evidence is inadequate.

The following table shows equivalency factors for converting other dioxins to 2,3,7,8-TCDD.

Volatile Organic Compounds VOCs

Benzene. Benzene is classified as a Class A carcinogen - Human Carcinogen based on adequate evidence of carcinogenicity from epidemiological studies. Benzene is readily absorbed through both oral and inhalation routes. The toxic effects of the benzene in humans and other animals include central nervous system effects, hematological effects, and immune system depression. Chronic exposure to benzene vapors can produce reduced leukocyte, platelet, and red blood cell counts.

Toluene. Toluene is categorized as a Class D agent which implies there is inadequate evidence of carcinogenicity. Toluene is absorbed in humans following both inhalation and dermal exposure. In humans chronic exposure to toluene vapors at concentrations of approximately 200 to 800 ppm (parts per million) has been associated with central nervous system and peripheral nervous system effect, hepatomegaly, and hepatic and renal function changes.

Ethylbenzene. Ethylbenzene is categorized as a Class D agent which implies there is inadequate evidence of carcinogenicity. In humans, ethylbenzene is characterized by its irritancy to skin and mucous membranes. No data are available on the teratogenic, mutagenicity or reproductive activity of ethylbenzene.

Xylenes. Xylene is categorized as a Class D agent which implies there is inadequate evidence of carcinogenicity. The three xylene isomers, compounds having the same chemical constituents in a different configuration, have similar toxicological properties and are discussed together. When inhaled at high concentrations, xylene causes central nervous system depression; it can also cause reddening of the face, disturbed vision and salivation. There is some evidence suggesting that xylene sensitizes the myocardium to the endogenous neurohormone, epinephrine and can precipitate heart failure and death. Workers chronically exposed to xylene display symptoms similar to those seen in acutely exposed individuals. In addition, there have been reports that disturbances in the blood can occur from xylene exposure. There are no studies to indicate that xylene is carcinogenic or mutagenic.

Methylene Chloride. EPA has classified methylene chloride as a B2 - Probable Human Carcinogen. Methylene chloride is absorbed following oral and inhalation exposure. Acute human exposure to methylene chloride may result in irritation to the eyes, skin and respiratory tract; central nervous system depression, elevated carboxyhemoglobin levels and circulatory disorders that may be fatal. Chronic exposure of animals can produce renal and hepatic toxicity. Several inhalation studies conducted in animals provide clear evidence of methylene chloride's carcinogenicity. There is only suggestive evidence in experimental animals that hepatocellular carcinomas and neoplastic nodules arise from oral exposure.

Trichloroethene. EPA has classified trichloroethene (TCE) as a B2 - Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. TCE is a central nervous system depressant following acute and chronic exposure. High level exposure can result in death due to respiratory and cardiac failure. Hepatotoxicity has been reported in human and animal studies following acute exposure to TCE.

Trichloroethylene. EPA has classified trichloroethylene as a B2 -Probable Human Carcinogen based on inadequate evidence in humans and sufficient evidence of carcinogenicity from animal studies. Trichloroethylene may damage the liver and other organs following chronic exposure. High level exposure can result in death due to cardiac failure.

Tetrachloroethylene. EPA has classified tetrachloroethylene as a Group C - Possible Human Carcinogen, based on conflicting evidence in humans, and as an experimental carcinogen from animal studies. Inhalation of vapors from tetrachloroethylene may affect the liver and may be a depressant to the central nervous system.

INORGANICS:

Metals

Arsenic. There is inadequate evidence for the carcinogenicity of arsenic compounds in animals. There is sufficient evidence, however, that these compounds are skin and lung carcinogens in humans. EPA classifies this compound as a Class A - Human Carcinogen. Oral doses to experimental animals produced phototoxic symptoms indicating arsenic to be teratogenic. Weak or negative results were obtained in most bacterial tests for mutagenicity. Toxicity depends on the chemical form of arsenic, arsenites (As[+3]) are more toxic than arsenates (As[+5]), along with the route and duration of exposure.

Cadmium. The evidence for carcinogenicity in humans is limited and is based on a study of lung cancer in cadmium smelter workers. Evidence for carcinogenicity in animals was considered sufficient based upon subcutaneous and intramuscular injection studies. The U.S. EPA, therefore, classifies cadmium as a B1 - Probable Human Carcinogen. Cadmium has been shown to reduce fertility and cause teratogenic effects in experimental animals following intravenous, intraperitoneal and subcutaneous administration. Cadmium has also been shown to be weakly mutagenic.

Lead. Lead and most lead compounds are classified by the U.S. EPA as Class B2 Carcinogens - Probable Human Carcinogens, resulting from sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans. Lead is stored in the body in bone, kidney and liver (EPA, 1984e). The major adverse effects in humans caused by lead exposure include alterations in the hematopoietic and nervous systems. The toxic effects are generally related to the concentration of this metal in blood. Mutagenicity cannot be determined from short term tests due to cellular toxicity. Subchronic and chronic exposures of rats and mice to lead have resulted in teratogenic and reproductive effects. Teratogenicity of inhaled lead has also been observed in humans occupationally exposed to lead.

Zinc. Zinc is categorized as a Class D agent which implies there is inadequate evidence of carcinogenicity. Zinc is an essential trace element that is necessary for normal health and metabolism and therefore is nontoxic in trace quantities. Overexposure to zinc has been associated with gastrointestinal disturbances, dermatitis, and metal fume fever, a condition characterized by fever, chills, coughing, dyspnea, and muscle pain (EPA, 1984). Chronic oral exposure of humans to zinc may cause anemia and altered hematological parameters. There is no evidence of teratogenic or carcinogenic effects.

EXHIBIT B

ARARS IDENTIFIED FOR THE FINAL REMEDY

EXHIBIT C

CALCULATION OF HBCLs FOR SOILS

EXHIBIT C

Action Levels for Excavation of
Organics-Contaminated Soils at the Broderick Site

This Exhibit describes a methodology for applying the health-based cleanup levels (HBCL), as presented in Section 2.1 of the Feasibility Study for the BWP site and Table 11 of this ROD, for excavation of organicscontaminated soils at the site using cleanup level indices. As discussed below, these cleanup level indices are similar in concept to the hazard index used to evaluate noncarcinogenic effects. A cleanup level index ensures that remediation meets the target risk level for site cleanup, when using the health-based cleanup levels presented in Table 11. This approach is consistent with risk assessment principles. The methodology is presented in two parts: first, a description of the cleanup level index approach and its use for evaluating cumulative health-effects for all compounds is presented; second, an example is provided to demonstrate the application of the cleanup level index.

CLEANUP LEVEL INDEX

The procedure presented in section 2.1 of the FS for developing health-based cleanup levels (HBCL) calculated a concentration for individual constituents in a particular medium that is at an acceptable risk level (where risk level is defined as either a specified individual lifetime cancer risk or a hazard index less than 1). In many cases, one or two constituents are responsible for much of the potential cancer risk or non-carcinogenic effect estimated for a site, so reducing concentrations of all constituents below their HBCLs should reduce total risks below their target levels. To make sure this is actually the case, the following methodology is proposed.

First, compare the concentrations of individual constituents in a sample with the individual HBCLs. If the concentrations are all below their individual HBCLs, then the cleanup level index (CLI) may be less than 1, but this condition would need to be verified by using the following computations. (If the concentration of one or more constituents are above their individual HBCLs, then it can be concluded that the CLI is greater than 1 without completing any further computations.) Second, segregate chemicals into those with HBCLs using carcinogenic effects as their endpoint and those using noncarcinogenic effects as their endpoint. For chemicals using carcinogenic effects as their endpoint, a cleanup level index is calculated.

Nc
CLI[c] = Cj/HBCLj (1)
j = 1

where:
CLI[c] = cleanup level index for carcinogenic effects,
Cj = concentration of chemical j in a particular medium,
HBCLj = health-based cleanup level for chemical j, and
Nc = number of chemicals with HBCLs using carcinogenic effects as their endpoint.

If CLI[c] is less than 1 then the sum of the risks associated with these chemicals is less than the acceptable cancer risk level. To show that this is the case, recall that HBCLj is defined as

HBCLj = ARL/URFj (2)

where:
ARL = acceptable risk level, and

URFj = unit risk factor for chemical j.

Substituting Equation 2 into Equation 1 gives the following:

Nc
CLI[c] = Cj ù URFj/ARL (3)
j = 1

If CLI[c] is equal to or less than 1, then Equation 3 can be rearranged to give:

Nc
ARL Cj ù URFj (4)
j = 1

Since the quantity Cj ù URFj gives the risk level associated with chemical j, then Equation 4 indicates the sum of the individual chemical risks are below the acceptable risk level. Thus, if CLIs as given by Equation 1 is less than or equal to 1, then the cumulative risk associated with all chemicals is less than the acceptable risk level.

EXAMPLE

To illustrate this application of the cleanup level index, consider a hypothetical site with four locations being considered for remediation. There are 20 chemicals with potential carcinogenic activity that are being evaluated at this site. These chemicals are named A1 through A20. Healthbased cleanup levels (HBCLs) have been developed for each chemical based on these potential carcinogenic effects and the HBCL for each chemical is presented in Table 1. Additionally, we have presented HBCLs divided by the number of chemicals (20). Also presented in Table 1 are concentrations observed in each location.

Remediation would be required in Locations 1 and 2 because the concentrations of some chemicals (i.e., D, E, F, and G) exceed their HBCLs. At Locations 3 and 4, the concentrations are below HBCL for each chemical. However, the total cleanup level index (CLI) for Location 3 exceeds 2, indicating remediation will be required. The total CLI at Location 4 is below 1, indicating the total cancer risk associated with all chemicals is below the target risk level.

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ROY ROMER
Governor

JOEL KOHN
Interim Executive Director

March 3, 1992

Mr. Jack McGraw, Acting Regional Administrator
U.S. Environmental Protection Agency, Region VIII
999 18th Street
Denver, CO 80202-2405

Re: State of Colorado Concurrence with the Broderick Wood Products Operable Unit #2 Record of Decision

Dear Mr. McGraw:

The State of Colorado, through the Colorado Department of Health (the State), concurs with the Proposed Plan and Record of Decision for Operable Unit #2 at the Broderick Wood Products site at 5800 Galapago Street in unincorporated Adams County, Colorado. This concurrence is based on currently available information indicating the nature and extent of contamination from the historic wood treating activities at the site. We believe the selected remedy will be protective of human health and the environment, complies with federal and state requirements, and meets the relevant and appropriate criteria of CERCLA.

The State and EPA have had discussions concerning the nature and extent of contamination and the selected remedy at the site. The following items were found to be of concern at the Broderick Wood Products site:

1) We concur with the waiver of ARARs for the remediation of the Denver aquifer under the Broderick property because of the site-specific hydrogeologic characteristics and present technical engineering limitations. We agree that institutional controls and monitoring will be required. The remedy must be reconsidered if new information indicates that it is technically practicable to treat the Denver aquifer under the Broderick property or if monitoring shows that institutional controls do not protect public health.

2) We concur with the development and implementation of the appropriate institutional controls to prevent exposure to and use of residual contaminated soil and ground water at the Broderick site. Institutional controls must be required to ensure the necessary level of permanence, and protection of human health and the environment as contemplated by the ROD. Long term operation and maintenance of any institutional controls imposed at the site will require a careful determination that the selected mechanisms protect public health and the environment.

The Department of Health will actively participate in the RemedialDesign and Remedial Action phases of Operable Unit #2 at the Broderick Wood Products site.

Sincerely,

Thomas P. Looby, Director

Office of Environment
Colorado Department of Health

3/18/92
Date